TECHNOLOGICAL MUSEUM, SYDNEY.

Building and Ornamental Stones

— OF —

Australia.

R. T. BAKER, F.L.S., &c.,
CURATOR.

We replace the Bark Gunyah with Stone and Marble Cities.

J. W. Tremain, Photo.

SYDNEY SANDSTONE.

(LENNOX BRIDGE, LAPSTONE HILL.)

The first stone bridge constructed in Australia, 1833. It is on the main western road over the Blue Mountains from Sydney, and is named after its constructor.

C. F. Laseron, Photo.

SYDNEY SANDSTONE.

(LANSDOWNE BRIDGE, GEORGE'S RIVER, N.S.W.)

On the main Southern Road, 16 miles from Sydney. Built of sandstone obtained from the neighbourhood, and opened for traffic, 26th January, 1836. Built by Wm. Lennox, with the authority of Major T. L. Mitchell, and was the largest stone bridge in Australia up to that date and for long afterwards. The arch is apparently elliptical.

TECHNOLOGICAL MUSEUM, SYDNEY, NEW SOUTH WALES, AUSTRALIA.

DEPARTMENT OF PUBLIC INSTRUCTION.

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JAMES NANGLE, SUPERINTENDENT.

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1915.

BY
R. T. BAKER, F.L.S., &c.,
CURATOR.

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INTRODUCTION.

[By The Minister of Public Instruction.]

THE aim of this work is to demonstrate that Australia has an unlimited supply of building and ornamental stones, which lend themselves admirably to the purposes of decorative art.

It is hoped that its publication will result in a greater appreciation of our resources, not only on the part of Australia, but of the world in general, while the technical information supplied by Mr. Baker must prove invaluable to all who are interested in town planning.

With the possession of such magnificent building material, and the gradual development of national artistic perception, there is no reason why we should not evolve a style of architectural decoration purely Australian.

I may be pardoned for pointing with pride to the industrial value of the important research work carried out by Mr. Baker and his colleagues at the Sydney Technological Museum, of which the publication of this volume is further evidence.

(Signed) CAMPBELL CARMICHAEL.

Building and Ornamental Stones of Australia.

(a)—HISTORICAL.

THE specific literature on this subject, since the foundation of the first Colony in Australia, 1788, is very limited. The most important factor militating against the use of our excellent building material in the past by the settlers was, no doubt, the abundance of such a good substitute as our hardwoods. However, in the case of Sydney, the Hawkesbury Sandstone, so abundant in the neighbourhood, was early employed by architects and builders, and this has remained the principal stone for this purpose to the present time.

It was not till nearly forty or fifty years after the English occupation of the continent that marble was brought into use, as shown in "Mitchell's Expedition into Australia," published in 1838, vol. II., p. 318, where occurs this reference :—"Near the Wollondilly, and a few miles from Towrang, a quarry of crystalline variegated marble has been recently wrought to a considerable extent, and marble chimneypieces, tables, &c., now ornament most good houses at Sydney. This marble occurs in blocks over greenstone, and has hitherto been found only in that spot."

Investigation has proved that this was in the locality or district which is now known as Marulan, and an authenticated specimen of that time is here illustrated. It is a mantel-piece taken from the house known as Barcom Glen, near Darlinghurst (now demolished), belonging to the late Mr. O. West. It is a beautifully coloured variegated marble, the white patches running very closely in texture to some of the Onyx Marbles of Mexico, with blotches of a rich red colour, and is probably one of the most handsome marbles found in New South Wales.

In the Great International Exhibition of 1851 in London, there appears to have been no exhibit of building and ornamental stones from Australia proper, but Tasmania is credited with the following:—Marble—Maria Island; partially dressed; sent by W. Stoutt. Marble—Maria Island; cut and dressed as paper weights; sent by J. Boyd. Grey Granite—Flinder's Island; sent by J. Mulligan. Granite—East Coast of Van Diemen's Land; sent by J. Mulligan. Granite—Hampshire Hills; sent by J. Mulligan. Porphyritic Granite—Webb's Harbour; sent by J. Mulligan. Limestone—Fingal and Break-o'-day; sent by J. Mulligan. Limestone—Maria Island; His Excellency Sir H. J. Denison. Limestone—Mersey River, between Hobart Town and Bridgewater. Limestone—From foot of Mt. Wellington; J. E. Bickero.

In the Paris Exhibition of 1855, the Commissioners of New South Wales exhibited a White Marble from Abercrombie, and a Green Marble from Emu Swamp. At the same Exhibition, Mr. W. Patten, of Sydney, exhibited a specimen of Argyle Marble (Marulan).

The next Exhibition record is the International Exhibition of London, in 1862, where the Colonial Architect, New South Wales, Mr. A. Dawson, contributed stones and timber used in building. viz:—(1) Eight specimens of sandstone from Sydney and suburbs; (2) Six specimens of sandstone and one of granite, from the Hunter River district; (3) One specimen of trachyte,

one of granite, and one of limestone, from the Peel River district; (4) Specimens of porphyry from Port Stephens, and of pumice stone found on the sea coast; (5) Sandstone from the neighbourhood of Sydney, used in the erection of the lighthouse at Port Stephens; (6) Sandstone, from the Clarence River district; (7) Specimens of twenty kinds of timber, used in building on the Hunter River and Peel River.

Sir William Macarthur exhibited building stone, nine specimens from the Wianamatta and Hawkesbury rocks, near Camden.

From Cavan, near Yass, by J. S. Calvert, Esq.—(1) Limestone; (2) Marble; (3) Galena.

Marbles were exhibited from Burrowa by Mr. Laidlaw, and from the Australian Marble Works, on the Wollondilly River, by Mr. Patten. One specimen was exhibited by the former, and five by the latter.

By G. H. Cox, Mudgee. (1) Marble.

From Moruya, by W. S. Caswell, Esq. Granite.

By Captain Arthur Vyner, Tumut. Two specimens of marble, polished by W. Patten.

The next most important data concerning our building and ornamental stones will be found in Professor Liversidge's book "Minerals of New South Wales." Mr. Pittman, in his "Mineral Resources of New South Wales" gives a list of various New South Wales marbles.

Then followed a slack period, when little development took place in our local marbles, although Sydney sandstone was extensively drawn upon in all the States, more particularly of course in Sydney, where from early times onwards it was used in almost every form of plain and ornate decoration, mostly illustrating the ancient Greek and Roman types of

architecture, but in some instances the artist has indulged in modern conventionalisations, and being especially a free and easy working stone, it yields readily to the artistic fancy of the sculptor. Some of the finest buildings in Sydney and Melbourne are monuments of the stonemason's craft of this period.

During recent years, one or two local granites were gradually introduced into Australian architecture; but within the last decade our local marbles, however, have come rapidly to the front, and have received the appreciation to which they are justly entitled, for it is doubtful if any other country in the world is so rich in this particular decorative material. New South Wales is especially to be mentioned in this connection, as here greater development in these natural resources has taken place, whilst the other States may possess equally as good stones, but so far these have not yet been recorded.

At the Franco-British Exhibition, held in London in 1908, was exhibited the finest and largest collection of Australian building and ornamental stones yet sent out of the country, and it was awarded a Grand Prix, the jurors stating:—

> "The exhibits of marbles . . . were especially noteworthy and served to convey to British and Continental architects an adequate idea of the richness of New South Wales in these excellent materials, some of which were admitted by competent judges to surpass any European marbles found in commercial quantities . . . . . Specimens of granite were also shown with freestone, . . . and with the exhibits there were displayed enlarged photographs of the principal public and private buildings in Sydney, in which these materials have been used extensively."

It was the favourable reception throughout Australia of the two books already published on this local product of New South Wales that has brought about the enlarged scope of the present work, and so the subject matter is now treated as a Commonwealth one in this issue.

As Australian marbles are coming rapidly into use, it would seem that they are destined to play an important part in the industrial and commercial future of this Continent, which has been so lavishly endowed by bounteous Nature.

(b)—GENERAL SURVEY OF THE SUBJECT.

Now that Australia's wealth in this direction is daily becoming more widely known, literature on the subject is gradually being published from time to time. As stated in the historical sketch, only odd references to our building and ornamental stones are to be found in exhibition catalogues and State Mines Department publications. This Institution, however, was the first to bring into book form this side of technological geology.

The first book was published under the title of "Building and Ornamental Stones of New South Wales," and issued at the Franco-British Exhibition. As new data came to hand, a second edition was published in 1909, and as an Appendix, a lithographic survey of the Federal Capital area and neighbouring districts was added, in order that the records therein given might be of use to those architects to whose lot it will fall to build Australia's future metropolis.

The greater part of the material for this particular survey was collected, although rather hurriedly, owing to the time being limited, by Mr. C. F. Laseron, of this Museum, and the route of his travels is given on the map appended.

In the building of Australia's future capital, Canberra, it is hoped that, in view of the great wealth of building stones available, the words on the title page will, in this particular instance, be fully borne out, and that we shall also strive to emulate the Roman Emperor

Augustus, who is recorded to have said "that he found Rome brick, and left it marble;"—the Australian on his part—superseding the bark gunyah of the aborigines by a capital made of home granites and marbles,—a city that shall be even more durable and beautiful than that which to-day perpetuates in its monuments and edifices the architectural labours of this Emperor builder in stone.

Since the 2nd Edition was issued, a more extended technical research was undertaken on crushing and fire tests by the Author and Mr. J. Nangle, now Superintendent of Technical Education. These results were published in the form of a paper read before the Royal Society of New South Wales, and are given as an Appendix in this work.

The principal result brought to light by this investigation was undoubtedly the remarkable compression strength of our marbles. Thus a 3-inch cube of Caleula Marble sustained a weight of 84·96 tons before crushing, as against Barren Jack Granite breaking under a pressure of 68 tons.

Several of these tested specimens are shown in the text in their fractured condition just as taken from the 100 tons testing machine; and as far as I am aware, this is the first systematic series of building and ornamental stones of Australia yet investigated, so that the figures are of special interest.

It is worthy of mention that this great compactness of texture is a distinguishing characteristic of Australian marbles, and although practically only the surface of our quarries has been worked, yet solid blocks are obtained, and in the dressing for market, and in the finished article, no stopping is required, consequently it lends itself to thin cutting—a feature of great commercial value.

Although so many localities are now known from which excellent lithic building material can be procured in this State, yet the industry is only in its infancy. The prospective development of the trade, however, augurs well for the extension of the industry, although at the present time the value of the imported marbles and granites is somewhat considerable.

Australian rocks especially, possess all the qualities of the imported article, and in many features or characters are superior to them.

Much modern machinery has been installed for quarrying, cutting, and polishing; in fact, plant sufficient enough to comply with all architectural demands likely to be made upon it for some time to come, is now well established.

It therefore behoves us to take a pride in the development of our natural resources in this direction, and to appreciate our beautiful marbles, granites, &c., cognisant that they more than hold their own in appearance and hardness against the foreign competitor.

As regards quality, durability, and colour, the majority of our stones must be ranked first-class. The grey granites of Uralla, Trial Bay, and many others are certainly equal in colour and hardness to the best Scottish, so much imported, whilst our marbles are reputed to be harder; and many are unsurpassed in beauty by those imported from foreign countries.

Within the last year or two our local marbles have been utilised in many of the fine buildings erected, and now in course of erection, in Sydney, Melbourne, Adelaide, Brisbane, Perth, Hobart, and with very gratifying effects, a circumstance that should lead to their greater utilisation in future.

The demand for stone for monumental purposes is very large, but the supply is obtained almost entirely from abroad, in spite of the fact that so much excellent material lies at our very door, and needs only industrial development.

In this comparatively newly-settled country, where the art of city building may be said to be making great strides, it will be found that, in spite of the small and sparsely scattered population, a fair amount of attention has been given to our building and ornamental stones.

Building stone, such as Sandstone, has, of course, been used in Sydney since the City's foundation, and this beautiful working material being ready to hand and in great abundance, was early utilised, with the result that some very fine and noble edifices adorn the streets of this State capital, and it has even been used in architecture in Melbourne, Adelaide, and other large towns.

In recent years our architects, desiring to materialise their conception of beauty, but wanting variety of material, have turned to sources of supply other than the Sydney sandstone, and in searching for material to meet their requirements it was discovered that, in building and ornamental stones of first quality, Australia in general, and New South Wales in particular, has few compeers.

Although practically only the surface has been scratched, the indications show that the supply of building material is inexhaustible, and one is, therefore, perhaps justified in stating that this unquarried material represents a latent wealth that is of sufficient importance to give employment to thousands of workmen, and will be in the future a considerable factor in the prosperity of this island continent, especially when it is remembered that Belgium employs at the present time 37,000 men in its stone and marble quarries.

There is every reason to believe that many more beautiful stones will yet be unearthed when increase of population brings an increased demand; and further, the specimens exhibited in London and in this Museum, together with the illustrations and information herein given, will, without doubt, carry conviction concerning the extent of our wealth in building and ornamental stones.

The output is certain to increase, inasmuch as the " skyscraper " is a forbidden structure here, and so steel is not likely to enter into competition with other building material in the proportion that obtains in some other countries.

The desiderata at the present time in city structures of Australia are, durability, utility, and stateliness, combined with chaste decoration. All these qualities can be found in, or produced from, our various natural building stones.

The atmosphere of these climes is so pure and dry that little or no artificial measures are required to prevent the inroads of adverse climatic conditions upon our stones, and it is pleasing to note that stucco is almost a thing of the past in our buildings.

As every beautifying effect can be obtained from our natural sources of building material, there is no necessity to resort to artificiality, and the magnificent buildings of our towns bear full testimony to this.

It is, perhaps, not too much to say that almost every variety of colour will be found in our Australian marbles. At any rate, the degrees of colour from known specimens of to-day may be said to cover a very wide range—in fact, the colours are so variable that it would not be easy to give a colour classification.

A beautiful black marble occurs at Windellama, in New South Wales—comparable almost with the black marble of Belgium ; and in the same class could almost be placed the Victorian Buchan Marble, used so effectively in the decoration of the new Public Library at Melbourne.

Red is a colour frequently found, and is well illustrated in Red Borenore, Nemingha, Attunga, Fernbrook, and many others.

In New South Wales no distinctly blue marble is yet known, but one with a bluish stain has been found at Marulan, New South Wales.

Some fine brecciated marbles occur in New South Wales, the most decorative of all is probably that from Attunga, which, when polished, shows exceptionally big fragments, and so producing figures which would make most decorative majestic columns in large buildings.

Amongst yellows the rich gold from Rylstone is at present unique amongst Australian marbles, and the same might be said of the beautiful ivory-coloured stone also from that locality.

The variegated marbles are of sufficient variety to suit almost any task.

Our white marbles still require further investigation, only a few being at present known, and in this connection might be mentioned the statuary marble found at Gilmore, Tumut, in New South Wales. Only surface specimens have been obtained, but these are most promising, and are quite equal in quality to Carrara.

In the Bathurst district, also, are several very fine white marbles suitable for monumental and other purposes, chief of which is one from George's Plain, now being placed upon the market.

Australia is particularly rich in granites, but so far not many have been worked. The finer-grained deep red granite of Gabo is an excellent stone for decoration, as also are those from Tarana of equal texture.

Several richly red coloured, coarse-grained granites, the felspar crystals predominating, have recently been brought to light, such as Mudgee, Michelago, Tarana,

In grey granites, the varieties are very numerous, but the finest of all is the dark grey of Uralla, which is undoubtedly one of the finest granites yet found in any country, being full of life; and an excellent green toned granite outcrops at Albury, New South Wales.

The sandstones of Australia are of excellent building qualities, but vary in grain, texture, and colour, and so give to the architect a wide field from which to realise schemes of architectural designs and beauty emanating from an original brain.

Serpentines are practically an untouched field, although their occurrence is generally known. Good material is to be found at Port Macquarie, New South Wales, and a polished specimen is here shown. Queensland is also rich in this substance.

Another important quality of our marbles and granites is that very few flaws occur in them, so that during their preparation for use, such as turning, polishing, carving, &c., no "filling in" or other methods of cobbling are needed to produce a regular and even surface. This, of course, is a distinct gain.

In the matter of nomenclature, some Continental designations, such as St. Anne's, Brocatella, &c., have been introduced; but this want of originality is to be discouraged, and the trade, falling into line with the example set by this State, is now bestowing Australian names, and it is by such names that our building stones will in the future be placed on the world's

markets. It is obvious that this will be a decided advantage, for, besides giving the nationality of the product, which is only right, and as it should be, it will prevent a confounding of our building stones with those of other countries.

At present only a limited number of quarries are working, yet the output of these is sufficient to show that, for variation of colour, figure, hardness, polishing qualities, &c., Australia possesses some particularly fine building and ornamental stones; and the same remarks apply in nearly every instance to the known but unworked deposits.

Accessibility is an important factor in connection with building stones, and so, fortunately, most of the quarries and known deposits are within reasonable distance of the principal cities of the Commonwealth, or existing and prospective towns, and easily reached by road, rail, or water; so that with the opening up of the country by railway extension, these and other fields may be still further developed.

It, of course, will be noted that New South Wales materials are more fully described than that of any other State, but this is owing to their being more fully worked than elsewhere, where the indications for good stones are just as promising as in the Mother State.

It is further hoped that this publication will have the immediate effect of at least creating a local or Australian demand for our marbles, granites, trachytes, &c., for public and private buildings, if not for other parts of the Empire as well as the rest of the world.

I wish to acknowledge my indebtedness to the Hon. Campbell Carmichael, M.L.A., Minister of Public Instruction, for so kindly writing the Introduction; and also, for much assistance, to Mr. Charles Laseron of the professional staff of this Institution, and Mr. D. Cannon.

I have also to acknowledge, with many thanks, assistance rendered in procuring specimens and photographs by F. C. Krichauff, Chief Draughtsman, Lands Department, Adelaide; C. M. Kerr, Melbourne; W. Laycock, Adelaide; V. H. Ryan, Director, Tourist Bureau, for all the photographs illustrating Adelaide Public Buildings; W. H. Twelvetrees, Government Geologist, Tasmania, for much assistance in procuring specimens, photographs, and also data concerning Tasmanian stones; R. L. Jack, B.E., F.G.S., Assistant Government Geologist, Adelaide, for information concerning South Australia; Col. G. W. Watson, Chief Architect, Melbourne; and L. K. Ward, B.A., B.E., Government Geologist, Adelaide.

At the end is given a lithic map of the Federal Territory and adjacent districts, and it is hoped that the records herein given may thus be of use to those architects to whose lot it will fall to build Australia's future metropolis.

The two most important qualities necessary in building stones are: Colour and Durability.

(c)—COLOUR.

COLOUR is an all-important feature in the choosing of a stone, for when any particular kind is mentioned it is almost certain to be asked what is the colour?—a character that is almost invariably due to the presence of certain minerals. Our granites vary in degree of colour, and may be classified generally as red and grey, both fine and coarse grained; and when the presence of a particular mineral is sufficiently large to retain its distinctive colour, it is then applied to the whole, as for instance, Tenterfield, Barren Jack, Mudgee, and Gabo red granites, where the flesh-coloured felspar crystals predominate. Our grey granites present many shades

of these tints, and give a splendid choice to the architect to satisfy his ideals of harmony or contrast.

The great advantage of granite over marble is, that its colour is practically constant from the quarry to its final disintegration, and is never subject or liable to discoloration from cement or other foreign substances, or from climatic conditions, for the granites of the Sydney Post Office colonnade show no sign of changing colour after a thirty years' exposure, and the Montague Island bases of the columns, with their labradorite crystals, are resisting the inroads of climatic conditions very satisfactorily. Such constancy of colour, however, does not hold with sedimentary and metamorphosed rocks, for sandstones are generally lighter in colour, or *vice versa* when exposed. For instance, the mountain sandstone is very soft when first quarried, but on exposure hardens and becomes almost white, whilst the Pyrmont sandstone upon exposure changes to a very pleasing straw colour. In the fire test (*infra*) Sydney sandstone changes to light brick red, due no doubt to the presence of oxide of iron, a constituent that in all probability gives a dark brown colour to the Ravensfield sandstone.

In the case of marbles, colour plays a very important part and requires care and attention, for the market value of a stone is often influenced by its colour without regard to its strength and durability; and now that so many varieties are being submitted to the architectural world of New South Wales, it is hoped that a gratifying, artistic, and harmonious combination of stone colours will result. We have used the word harmonious because a building of many colours is not art, but at the same time a too sombre colour is not desirable in this climate of blue sky, for to our taste the new Railway Station at Sydney in its internal mural colours is rather inclined to the dull side of things.

The colour of a sandstone rock when freshly quarried may be pale coloured or perfectly white, but after a short time of exposure the colour may change to a buff or the stone may be streaked with irregular patches of ferrous oxide. Such discoloration depends chiefly upon the presence of impurities within the stone itself. The yellow of many limestones is often due to the presence of finely disseminated iron sulphide. If stone contain either the sulphide or the carbonate of iron, discoloration is a natural consequence of exposure to the atmosphere, and such stone often weathers buff after a few years. The oxides of iron are more stable compounds than the sulphide or carbonate, and are less liable to alteration.

Discoloration in the face of a marble wall may be due to impurities in the mortar, cement, or brick used in the construction, which are brought to the surface through capillary attraction. The iron stains in marbles in a wall are probably also due to the ferrous oxide in the mortar, cement, or brick used in the construction rather than in the marble itself. A preventative against ferrous iron in the brick or mortar of the back wall coming to the surface is a coat of asphalt between the back wall and the stone facing; or better still, the selection of lime, cement, and brick in which it is certain that ferrous iron is not present.

This question of discoloration of marble requires attention more than perhaps has been bestowed upon it in the past, or otherwise a public prejudice may set in against our beautiful stones. Many of our marbles, such as red and blue Borenore, Caleula, and Springhill, are being extensively used now on shop fronts in Sydney, Melbourne, Adelaide, Brisbane, Hobart, Perth, and many inland towns, and, it must be admitted, with good effect; but care must be taken with the backing in order that no foreign substance is likely to cause discoloration by capillary attraction.

Fortunately, the smoke, fog, and damp of the northern climes is mostly absent in this sunny south, so that much greater liberties can be taken with our stones in the matter of climatic exposure, and so less care is given to loss of, or injury to colour by these adverse conditions, as the original colour will not suffer so much from external causes alone. One great advantage under which our architects work in this country is that climatic conditions do not enter so largely in constructional calculations as obtains in some of the countries of higher latitudes, for we have a dry climate such as also obtains in Rome and Egypt, where we know that well-preserved specimens of the architect's art have been handed down through long ages, their preservation being due to the arid state of the atmosphere. Thus our architects have the opportunity of handing down their ideals of beauty, cut in stone, to the admiration of coming generations.

One great advantage enjoyed by our architects in working in what may be regarded as a comparatively equable climate, is that certain factors which must enter largely into the use of stone in colder countries are absent; here there are no extremes of heat and cold—agencies which must be studied when using stone where such occur, and such terms as "an unequal expansion" and "constriction" rarely give serious consideration here. When used for internal decoration, no attention need be given to atmospheric conditions, as the colour will, if not injured by defective backing material, almost invariably remain permanent, and a selection of stone, then, becomes merely a question of taste.

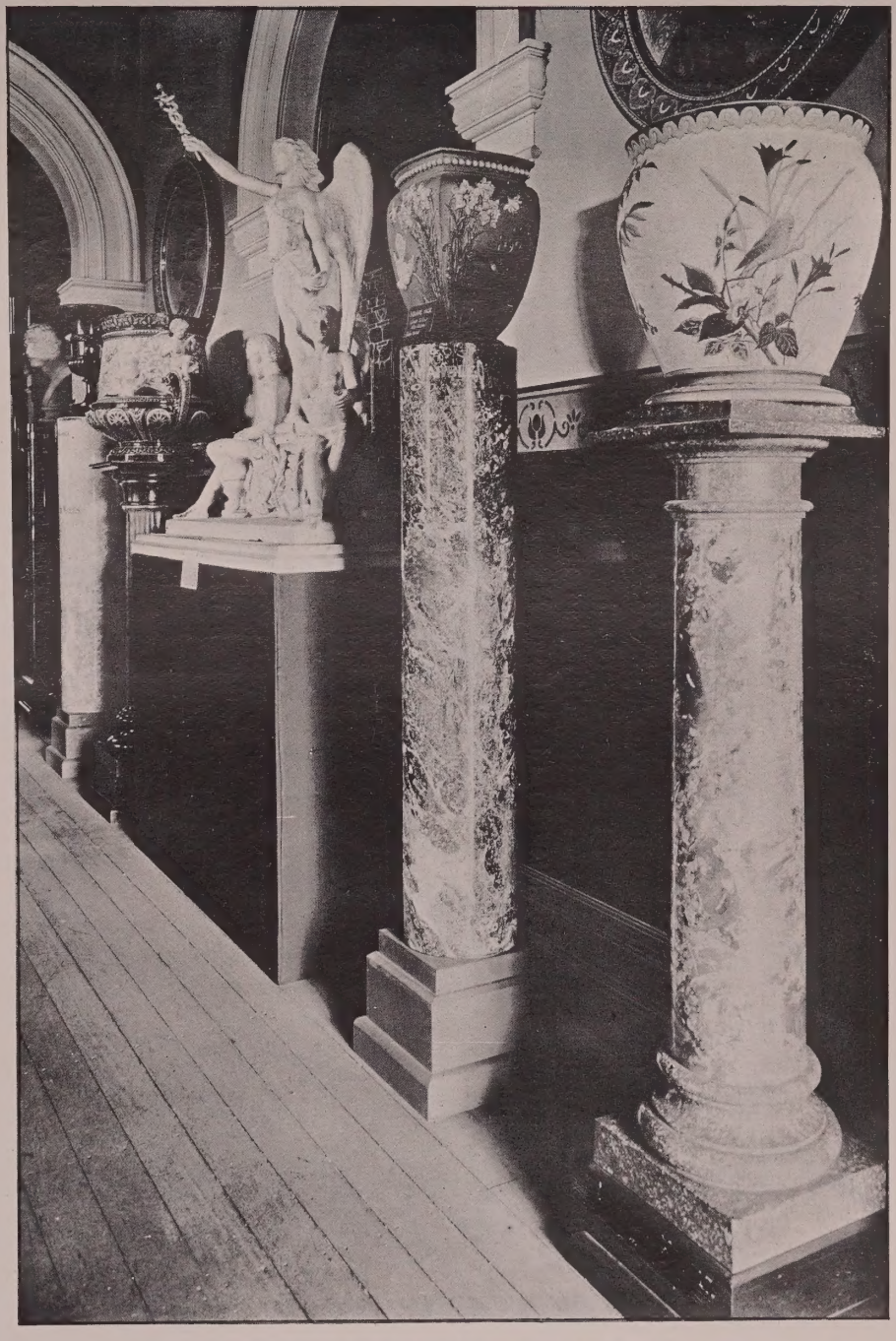
(d) DURABILITY.

It is perhaps too early in the life of our stones to give exact figures illustrating their durability, but our granites, trachytes, and sandstones so far appear to possess good lasting

qualities, although in a few isolated cases sandstones have shown signs of weathering or disintegration. This latter defect is perhaps due to a want of a proper selection of stone, for it appears the time has come when a stone expert is necessary, just as there is in commerce a wool or timber expert; one who should be well versed in petrology and make the study of this science his profession, and whose business should consist of passing all stone before it is placed in a building. There certainly must be something in the art of selecting, say, even a sandstone, as for instance, the stone of the Macquarie Obelisk, Sydney, which has now stood all weathers for nearly one hundred years, is as sound as the day it was erected.

(e) FIRE TESTS.

As far as we have been able to ascertain, no data existed concerning the refractoriness of our building stones until published by the author and Mr. Nangle, so that the information in this connection given below may be of value to architects and others interested in this feature. The samples tested were necessarily small, as muffles were not available to take larger samples. The typical rocks were only taken, and the results, few as they are, are comparative. Two methods were available for obtaining the temperature of muffle furnaces, viz.:—Siemen's pyrometer and Pitkin White's Thermo-electric pyrometer. The former was found to work very satisfactorily, so was used for all demonstrations. The samples subjected to this particular test were sandstones, marbles, trachytes, and granites, and the data speak for themselves. It may, however, be stated in passing, that the sandstones came through best in the different fire and water tests.



VESTIBULE, TECHNOLOGICAL MUSEUM.

I.—Granites.

THESE are fairly well distributed throughout Australia, over areas of various extent, in bosses and huge outcrops as well as in veins or dykes.

They range (1) in colour from dark red to pale pink, and various shades of grey, and even green, are to be recorded;—(2) in texture, from a fine to a very coarse grain;—(3) in varying degrees of hardness (apart, of course, from the weathered or semi-disintegrated portions); and (4) from uniformity to unevenness in the relative grain size of mineral constituents.

All over Australia are many more localities than those given, from which hand specimens have been obtained, and are exhibited in the various Museums, but, as they are only known from such specimens, their occurrences are not here recorded.

In Western Australia, Granites occur at Kellerberrin, Mahogany Creek, and Raelands.

(a) Red Granites.

Very few of these are being worked, but from numerous surface specimens obtained from different localities there can be no doubt that many good stones are yet to be found in Australia, and only require to be prospected.

The following are the principal known sources:—

ALBURY, N.S.W.—Some good granites occur here, but are not worked; the coarse-grained depicted will give some idea of the red varieties.

BARREN JACK, N.S.W.—A light but pleasing coloured red granite, with the facies of a marble; occasionally having a wavy figure. Mica is rather sparsely scattered, and the felspar here and there has a green tinge. It is hard, heavy, and a first-class building stone. The dam at Barren Jack Reservoir is practically built of this granite, some of the blocks weighing 15 tons.

Barren Jack, N.S.W.—*cont.*

BECKWORTH, Vic.—A medium coarse-grained stone occurs here, which is darker in colour than Gabo, but its brownish appearance may be detrimental to its utilisation in some branches of the trade.

GABO GRANITE, N.S.W.

Nat. Size.

BRAIDWOOD, N.S.W.—This is a red variety, similar in character, but rather lighter in appearance to that of Gabo Island, and is found in abundance at the south end of the town.

It is composed almost entirely of quartz and orthoclase, and very little hornblende and biotite. The felspar is a fine pink colour, and the texture being fairly coarse it should prove a valuable building stone, as it polishes well.

BROULA HILLS (COWRA), N.S.W.—This rock consists of an outcrop, or, more correctly, a series of outcrops, in these Hills about 12 miles westerly from Cowra. Apparently it occurs in a belt about half a mile to a mile wide, and over 2 miles long. It runs nearly north and south. (*J. G. Wyndham.*) It is a fine-grained granite with pegmatitic veins, and possesses a good rosy colour, and further developments would no doubt yield excellent ornamental stone. It is a promising red granite.

BUNGENDORE, N.S.W.—A fine-grained red aplitic granite outcrops about 8 miles to the north of Bungendore.

BUNGONIA, N.S.W.—There is red granite in this locality, but specimens have not come under the notice of the author.

CARRICK, N.S.W.—A very fine pink granite is found at Lockyersleigh, along the railway line. This granite is very hard, and takes a splendid polish.

COOMA, N.S.W.—A fine-grained red granite outcrops on the Berridale Road, 17 miles south-west from Cooma. (*A. E. Zeigler.*)

GABO ISLAND, N.S.W.—From this island have been obtained some of the best red-coloured granite used in the building trade of New South Wales; it is the only red variety that has so far been quarried to any extent in this State.

It is a particularly good granite, the constituents being mixed in about equal proportions, and so producing a fairly uniform texture. The colour is often a deep red, and so is spoken of in the trade as "possessing plenty of life."

It is specially suited for building, ornamental and monumental work, and the specimens exhibited at the recent International Exhibition held at Christchurch, New Zealand, were much admired by those interested in building and ornamental stones.

The deposit is large, and of easy access from the sea.

GRENFELL, N.S.W.—The low hills lying to the north and west of the town are composed of this material. The rock consists almost entirely of even-grained red orthoclase and quartz. It is, however, unworked.

INGLEWOOD, Vic.—This is a red granite, but too pale for most commercial purposes.

INVERELL, N.S.W.—A pale-coloured stone, with fine-grained felspar predominating. Area of deposit not known.

JERANGLE, N.S.W.—

(*a*) This is an even-grained rock, containing equal proportions of red orthoclase and quartz. It is very similar in appearance to the Braidwood red granite.

(*b*) Porphyritic red granite. This is a coarse-grained rock, containing numerous large crystals of red-coloured orthoclase up to 1 inch in diameter. Should take a very handsome polish.

JINDABYNE, N.S.W.—There is material here of unsurveyed area, which has not yet been worked. It much resembles Gabo in colour and texture, and may, perhaps, belong to the same formation.

I am indebted to Mr. W. A. Gullick, Government Printer, for the record of this locality.

LITHGOW, N.S.W.—A red porphyritic granite of good colour outcrops in the descent of the Cox River, 4 miles from Lithgow, on Rydal Road. Any quantity of stone is available.

MAFFRA, N.S.W.—This locality is 25 miles south of Cooma. The rock is a pink, somewhat pale-coloured granite, fine in grain, and takes a good polish.

MICHELAGO, N.S.W.—A good coarse, flesh-coloured granite is found on the Murrumbidgee River, near Michelago, associated with the porphyries of that district.

MIDGEE, near Charleston, S.A.—This is a good reddish stone of a coarse character, with large felspar crystals, and will no doubt be worked later on, as the demand for red granites extends.

MUDGEE, N.S.W.—The material occurring between Wellington and Mudgee consists of a remarkably coarse-grained red granite. The felspar occurs in large, irregular, red and dull-greenish or glassy-like patches rather than in well defined crystals, and gives the stone a characteristic appearance, which is quite unlike any other granite at present recorded for New South Wales. It may be said to resemble somewhat the coarse-grained specimens of granite of Norway in colour and texture. It takes a good polish, and arrises as sharp almost as a knife. There should be a good commercial future before this stone.

MULLOON CREEK, N.S.W.—A red, coarse, handsome granite occurs in unlimited quantities at this locality, which is situated 10 miles east of Bungendore. The colour is variegated, produced by the presence of a pink orthoclase and a pale-green vitreous plagioclase, whilst porphyritic quartz crystals also occur, along with hornblende and biotite.

MURRAY BRIDGE, S.A.—There is a good, fine-grained granite found at Swan Reach, Murray Bridge, but so far has not yet been used.

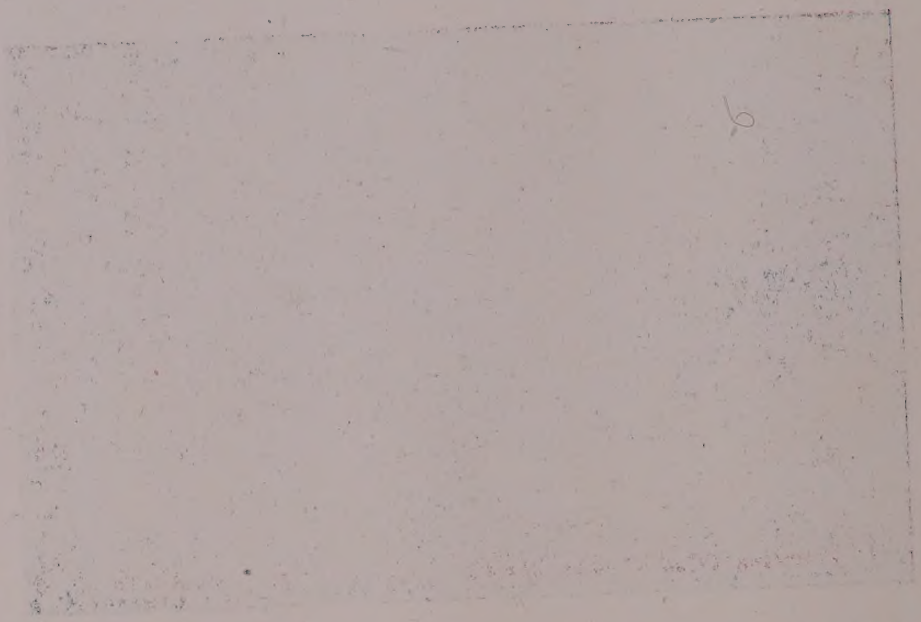
A pale yellowish material is largely used in Adelaide also from Murray Bridge, but although classed locally as a red, yet it might more correctly be called a pale yellowish, but by some it would be classed as a grey. It is coarse-grained and a good architectural material.

MURRUMBATEMAN, N.S.W.—Mr. W. Fairley states that a red granite occurs west of this town.

HEEMSKIRK GRANITE, TASMANIA.

MUDGEE GRANITE, N.S.W.

Nat. Size.



CABO GRANITE COLUMNS AND SYDNEY SANDSTONE.
(THE TREASURY BUILDING, SYDNEY, N.S.W.)

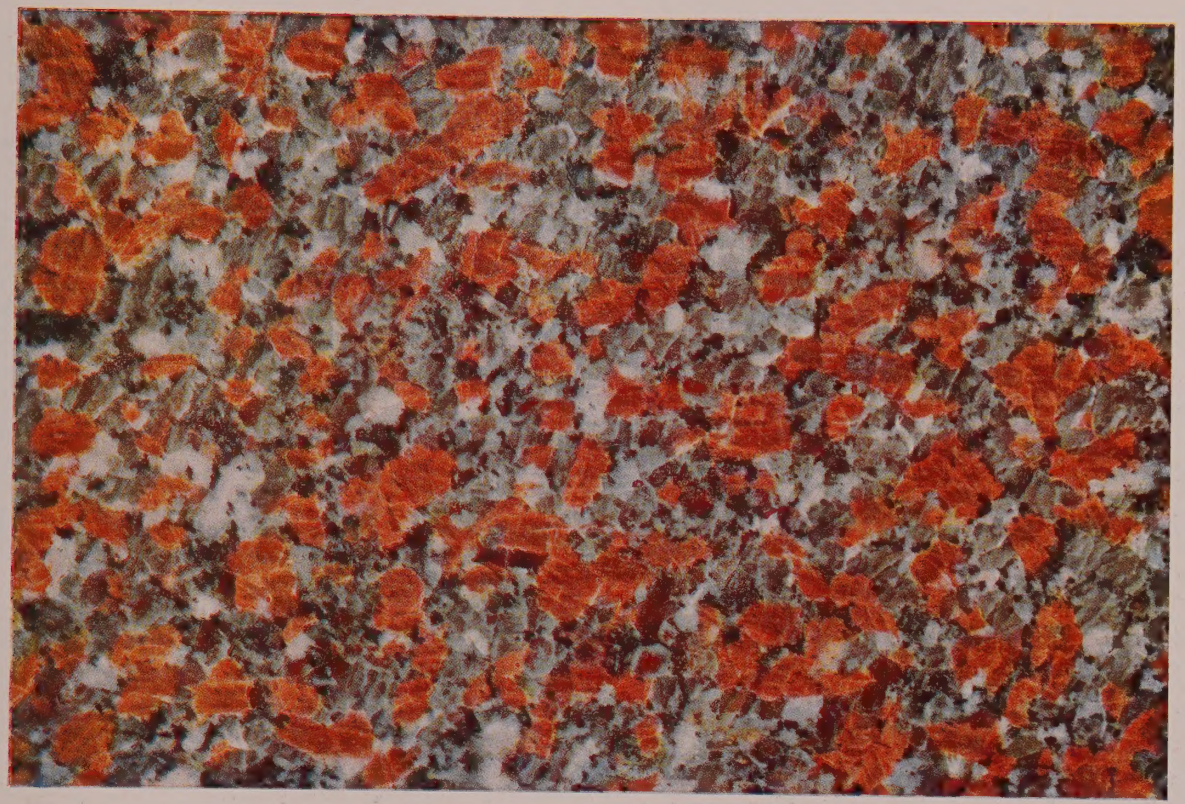
MURRAY BRIDGE RED GRANITE BASE.
(SOLDIERS' MONUMENT ADELAIDE SOUTH AUSTRALIA.)

MURRAY BRIDGE RED GRANITE, S.A.

BASE, MURRAY RIVER RED GRANITE.
SUPERSTRUCTURE, SYDNEY SANDSTONE.
(ADELAIDE, S.A.)

MORUYA GRANITE AND SYDNEY SANDSTONE.

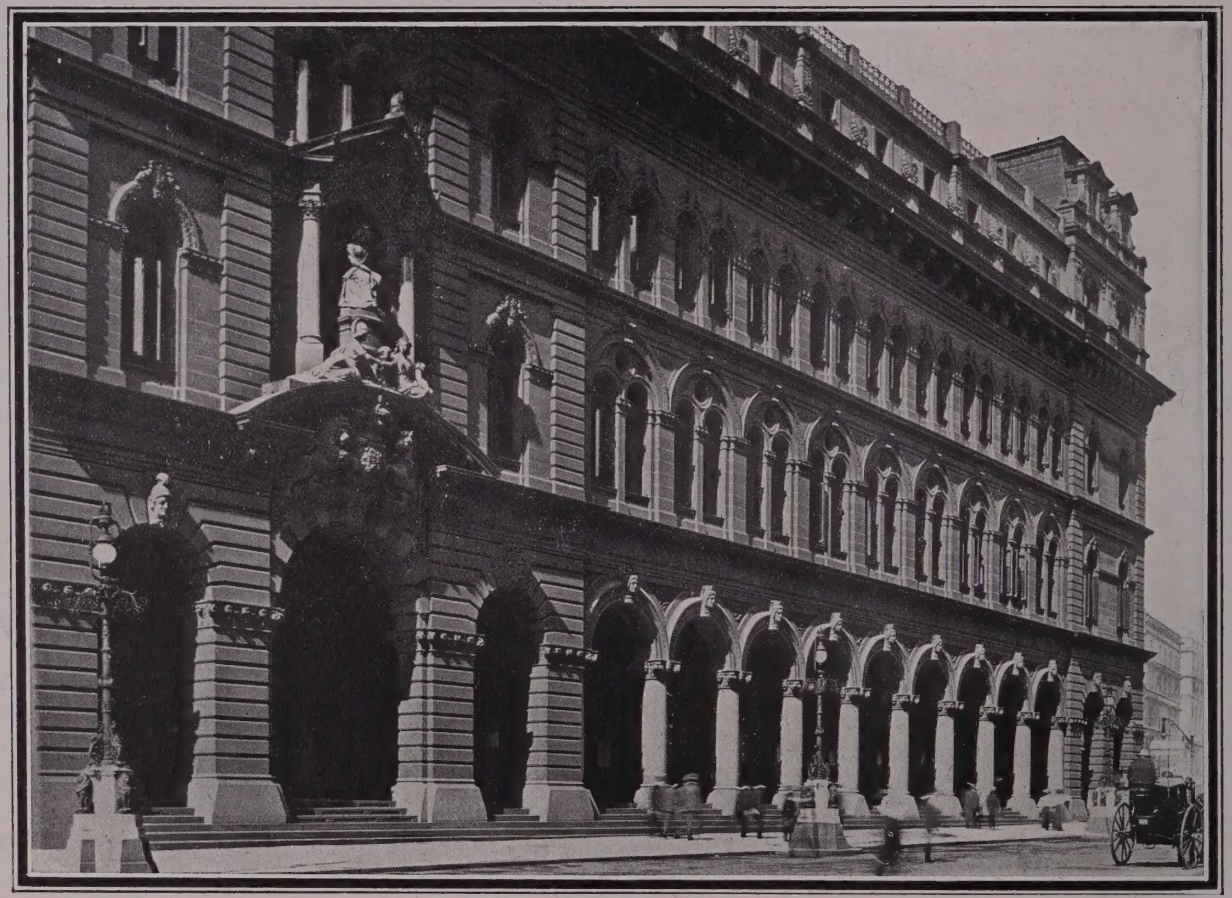
(GENERAL POST OFFICE, SYDNEY, N.S.W.)



TARANA GRANITE, N.S.W.

MORUYA GRANITE AND SYDNEY SANDSTONE.

(THE CUSTOM HOUSE, SYDNEY, N.S.W.)

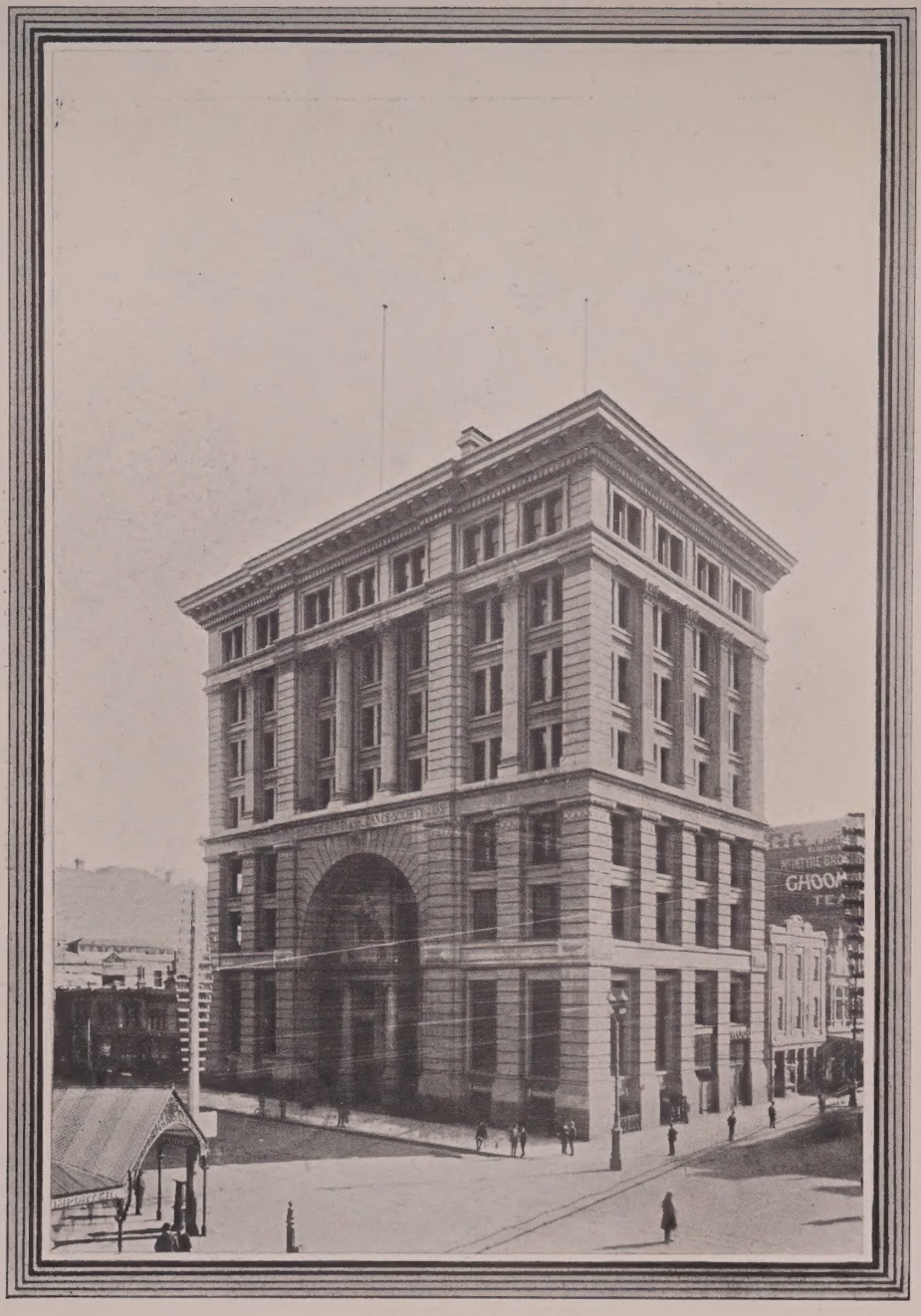


COLUMNS OF MORUYA AND MONTAGUE ISLAND GRANITE.

(COLONNADE, GENERAL POST OFFICE, SYDNEY, N.S.W.)

Nat. Size.

ALBURY RED PORPHYRITIC GRANITE, N S W.



HARCOURT GRANITE, VICTORIA.
(EQUITABLE LIFE INSURANCE MELBOURNE.)

WEST ISLAND GRANITE BASES.

(BANK OF AUSTRALASIA, ADELAIDE, S.A.)

RYLSTONE, N.S.W.—This large area of granite is said to produce a stone of great rarity and beauty.

TARAGO, N.S.W.—Extensive deposits of a flesh-coloured coarse-grained granite occur about 6 miles south of Tarago, on the Braidwood Road.

Quartz and felspar (orthoclase) make up the bulk of the rock. It has not been worked yet.

TARANA, N.S.W.—A very large development occurs in this neighbourhood, including several varieties, one a coarse rock with large porphyritic felspars of good colour, and another of a finer texture somewhat resembling Gabo.

TRIAL BAY, N.S.W.—This is a coarse, pale-red coloured stone, judging from surface specimens obtained and polished. The colour would probably improve on going deeper into the rock mass, and if so it should prove an attractive building and ornamental stone,

Trial Bay, N.S.W.—*contd.*
as the texture is rather pleasing. It has the facies of the Jonesborough granite, Vt., U.S.A., or Trowsworthy granite, Gloucester, England. It is the hardest granite yet turned in a lathe in Sydney.

WOMBEYAN, N.S.W.—A red granite occurs here in a large boss, but has never been worked. Only surface specimens have been examined, so that no correct data can be given concerning its commercial value.

WOOLAMI, Vic.—A pale reddish coloured medium-grained stone has been quarried from here, and specimens are to be seen in some fine large columns and base courses in the Equitable Buildings in Melbourne.

WUDINA, S.A.—A good, coarse-grained granite outcrops in this locality and occurs throughout an extensive area. It has deep red colour and is full of life.

(b) Grey Granites.

These varieties of granites, as far as at present known, are more extensive and numerous than those of the red varieties. Like them, however, they also vary in texture and structure, as well as in shades of colour. They are all excellent building stones, and will, without doubt, be largely used in our city architecture of the future.

The following are some of the best-known localities for grey granites:—

ADELONG, N.S.W.—The grey granite of this locality has been quarried near the town, and used for paving the streets of Tumut, and on the authority of Mr. J. Turner, of Goulburn, it is an excellent commercial stone.

ALBURY, N.S.W.—In this district a great number of granites abound, the varieties being too numerous to particularise here. There is a dark-green granite that is worthy of development, as it much resembles serpentine in colour (*vide* Coloured Plate).

The fine-grained granite reminds one of that of Richmond, Va., U.S.A., but is a shade darker—a rather good feature; the coarse-grained samples are very distinctive and quite unlike any others from New South Wales. With such variety and choice of stones the cities of the future of this district should be amongst the most beautiful in the Commonwealth.

ARNPRIOR (LARBERT), N.S.W.—A grey granite, similar to that at Braidwood, is the chief rock in this locality.

BATHURST, N.S.W.—A coarse-grained bright stone occurs to the south, and has been used in monumental works in the town.

BEECHWORTH, Vic.—Specimens of a coarse-grained granite with a full deep colour have been obtained from near here, but no data are available as to the quantity.

BRAIDWOOD, N.S.W.—Extending almost from Tarago right into Braidwood, a distance of 18 or 19 miles, is a coarse-grained variegated hornblendic granite, somewhat resembling that of Table Mountain, Albury.

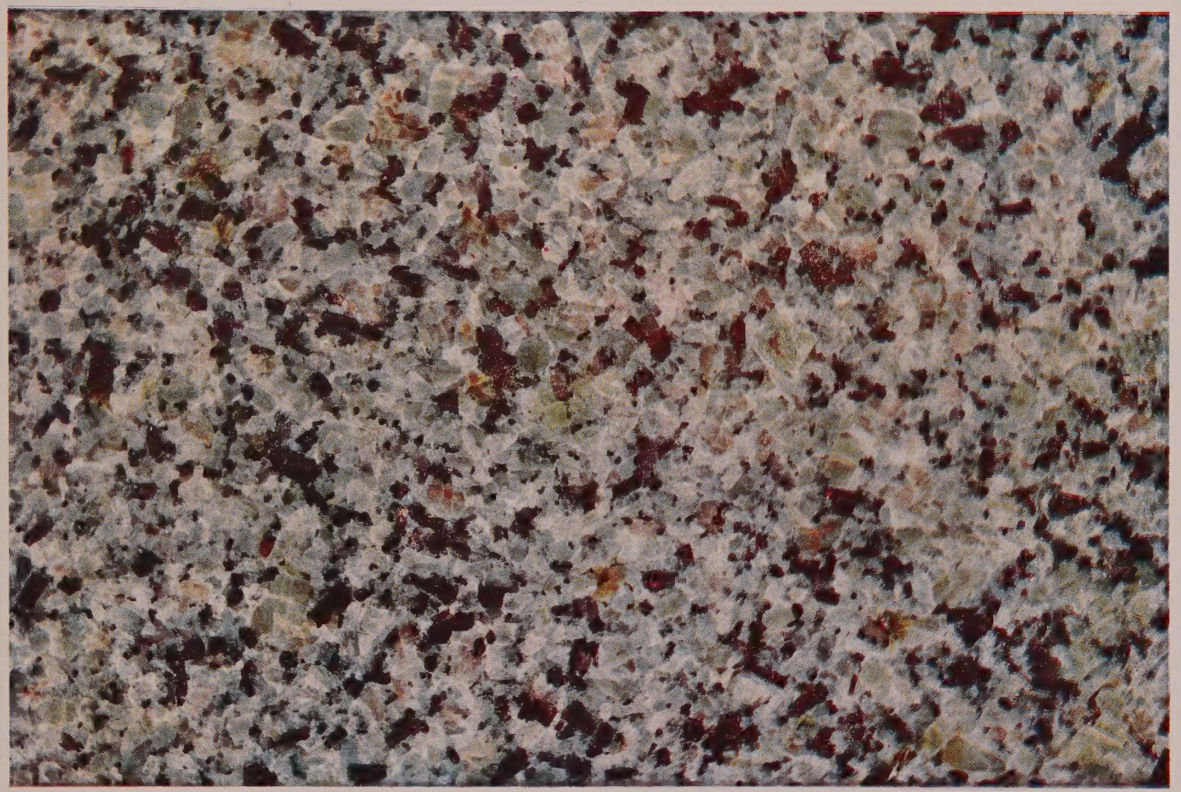
There are two species of felspar present, the larger portion consisting of pale-coloured plagioclase with a faint greenish tinge. There is also some pink orthoclase, and clear glassy quartz in abundance.

It is an excellent ornamental building material, and the Anglican and Roman Catholic Churches are constructed of it, besides many of the business houses and residences in the town; and being in unlimited quantities it should be a very valuable building stone in the future.

Another variety is fine-grained, and occurs at the south end of Braidwood. It is, however, pale in colour, and the exposed blocks examined were too much weathered for one to give an opinion as to its fitness for building purposes. It requires, therefore, further investigation.

BREADALBANE, N.S.W.—The Gunning granite extends eastwards within 3 or 4 miles of Breadalbane, and within 8 miles of Goulburn. (*J. Turner.*)

BREDBO, N.S.W.—A hard, fairly coarse granite outcrops about 7 miles to the east of this township. It is similar in appearance to the Jerangle grey granite, but is lighter in colour.



BATHURST GRANITE, N.S.W.

BUNGENDORE, N.S.W.—A very hard, tough, grey granite outcrops between 4 and 5 miles north of this township on the Tarago Road. The rock is coarse in texture and outcrops in large boulders, which could be easily quarried.

BURROWA, N.S.W.—A coarse-grained grey granite is found in this district.

COLLINGWOOD, near Gunning, N.S.W.—Here a quarry has been opened out. (*J. Turner.*)

COOMA, N.S.W.—On the Berridale Road, about 9 miles from Cooma, a fine-grained dark-coloured granite outcrops.

COWRA, N.S.W.—This rock is very abundant in the immediate neighbourhood, the lofty hill to the north of the town being entirely composed of this material. The texture of the stone is medium, and the colour dark, taking, when polished, a slight bronzy lustre, which makes it a very handsome stone. It is easily quarried and worked, and, outcropping within a short distance of the railway line, this should be a valuable building stone in the future.

GLADSTONE, Tas.—A light-coloured granite is found in this locality, which is in the north-eastern portion of the island.

GOULBURN, N.S.W.—Granite is one of the most common rocks in this district.

GUNNING, N.S.W.—There is a large outcrop of a good free-working grey granite at Collingwood, near this township. The stone punches well, and is hard enough to take a good polish.

Gunning, N.S.W.—*contd.*

A first-class granite outcrops about 6 miles west of Gunning, and in fact, constitutes the whole surface of the countryside between that spot and the town, but at present is not much worked, although the Anglican Church and several private houses are built of it.

It is a fine-grained hornblende granite, hard, tough, and dark in colour. The abundance of hornblende gives the stone sufficient colour for commercial purposes. Looks very well polished.

HARCOURT, Vic.—

(1) This is a coarse-grained grey granite that looks well when polished, having a good colour, and is the most extensively used granite in architecture in Melbourne. Its effectiveness is shown in such buildings as State Parliament House (Columns under portico), Savings Bank, Equitable Buildings, and several others.

(2) A fine-grained grey stone is also obtainable from this locality, as well as a pale pink one.

HARDEN, N.S.W.—Large outcrops of grey granite occur throughout the district. The rock is bright in colour, fresh-looking, and fairly tough.

HARROW, Vic.—A rather medium-grained granite, with greenish tint, and appears to have good points which favour a trial of its use.

INVERELL, N.S.W.—A pale-coloured coarse-grained granite is quarried here and used for building purposes in the town.

JERANGLE, N.S.W.—

(*a*) Hornblende granite. This is a fairly coarse rock, with abundance of clear glassy quartz and large crystals of hornblende. It outcrops in the mountains to the east of Jerangle, in the form of large tables or floors, and so is easily quarried.

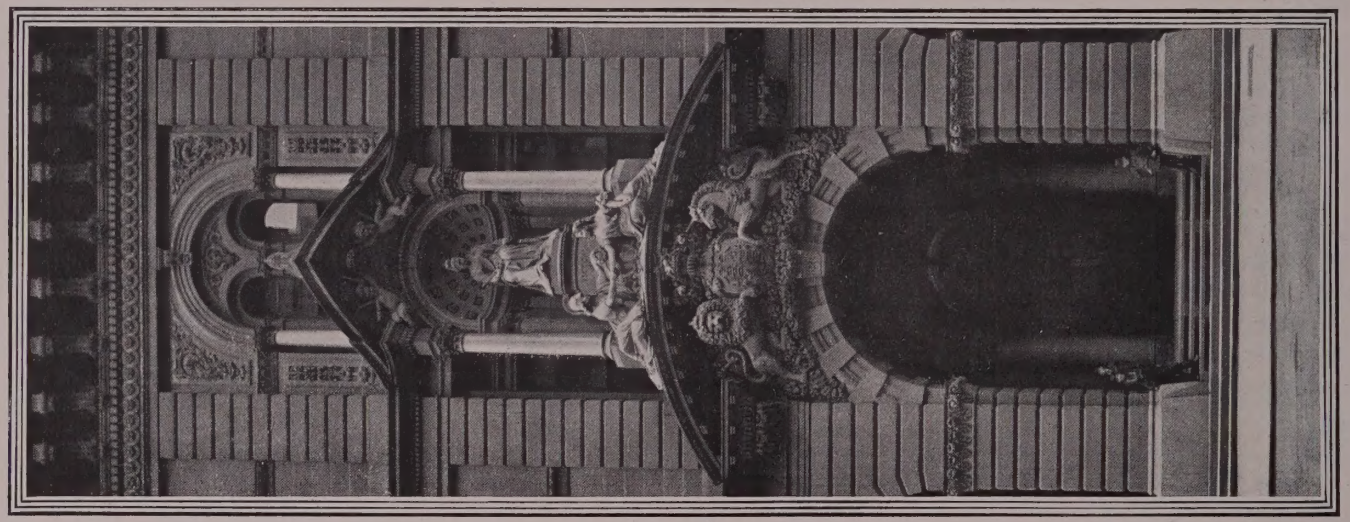
(*b*) Porphyritic grey granite. The base of this rock is of a very fine aplitic nature, and dark-grey in colour. Large porphyritic crystals of white felspar are abundant, while those of quartz are less common. Should polish very well.

LAKE BATHURST, N.S.W.—Grey granite is plentiful in the neighbourhood of this sheet of water.

MALDON, Vic.—Specimens of a coarse-grained granite with a full deep colour have been obtained from this locality, but no data are available as to the quantity.

MECKERING, W.A.—A fine-grained granite is obtained from this locality, which is on the Eastern Goldfields Railway. (*Maitland and Jackson.*)

MINIPPA, S.A.—A coarse-grained granite occurs here and gives much promise as a building material.



MORUYA GRANITE COLUMNS.
(MAIN ENTRANCE TO GENERAL POST OFFICE, SYDNEY.)

MONTAGUE ISLAND, N.S.W.—This is rather of unusual structure, the large crystals of felspar (labradorite) being its chief characteristic.

It has been utilised in the Sydney General Post Office with pleasing effect. It takes a good polish, and is close-grained, compact, and hard in texture. This is one of the most elegant of our grey granites, and is less marked with dark basic segregations so characteristic of grey granites generally.

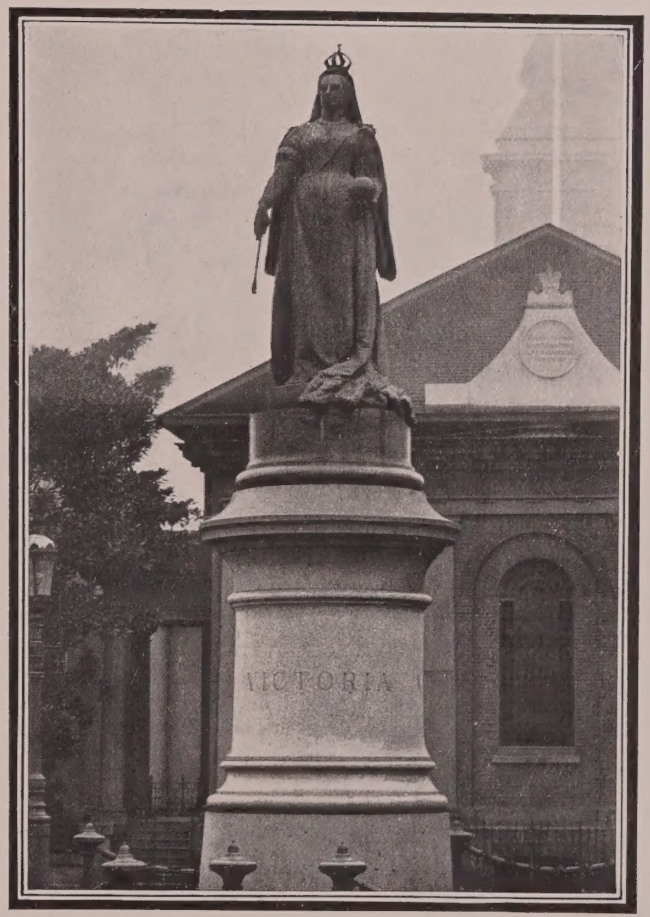
MOODY, S.A.—This stone is of excellent quality and of a medium coarse-grained even texture and colour, and is one of the finest of this class of granites in Australia.

MORUYA, N.S.W.—A medium coarse-grained material, possessing a rather palish yet pleasing colour. Its otherwise uniform texture is now and again broken by basic segregations, which rather adds to its architectural effects.

The large main columns of the colonnade of the General Post Office, Sydney, are constructed of this material, and their general effect is much admired. It has also been utilised in many other Sydney buildings.

OBERON, N.S.W.—This is a bright-coloured stone with a pinkish tinge, the black mica being specially pronounced by the lustre of its fractured surface, and contrasting well with the felspar.

TALLANGATTA, Vic.—A beautiful tourmaline granite has been recorded from this locality, but is only known from hand specimens.



MORUYA GRANITE PEDESTAL.
(QUEEN VICTORIA STATUE, SYDNEY, N.S.W.)

TENTERFIELD, N.S.W.—A beautiful porphyritic stone, and unlike any recorded granite. The large flesh-coloured felspar crystals scattered throughout a grey-coloured ground, produce a very pleasing effect, and give the stone a most attractive appearance. It is a splendid combination, so to speak, of red and grey granite, and has great commercial possibilities.

TREWOOL, Vic.—This stone is characterised by its rather greenish-tinted felspar crystals. It has been used in several large business premises in Melbourne.

TRIAL BAY, N.S.W.—The grey granite occurring here is quite equal to the best Peterhead, having a fresh, bright colour, or what is known in the trade as "life"—the polished and chiselled surfaces contrasting well in decorative work.

TUMUT, N.S.W.—A deposit of this stone occurs near the serpentine belt, 16 miles N.E. of Tumut.

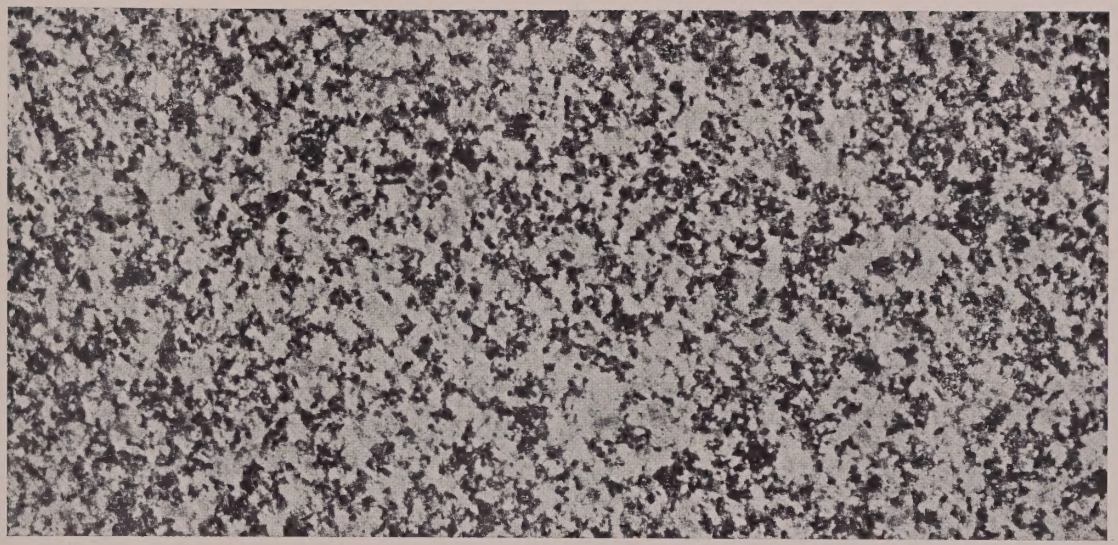
URALLA, N.S.W.—A very attractive hornblende or dioritic granite is found here, and is one of the best coloured yet seen in the State. It is a splendid monumental and ornamental stone, and superior to the best Peterhead. It has been compared to the famous Bessbrook, Co. Armagh, Ireland, and will be an esteemed stone when placed on the market.

WEST ISLAND, S.A.—This is perhaps the most extensively used of all the South Australian granites, and figures largely in the most important public buildings, such as St. Peter's Cathedral, Parliament House, banks, &c.

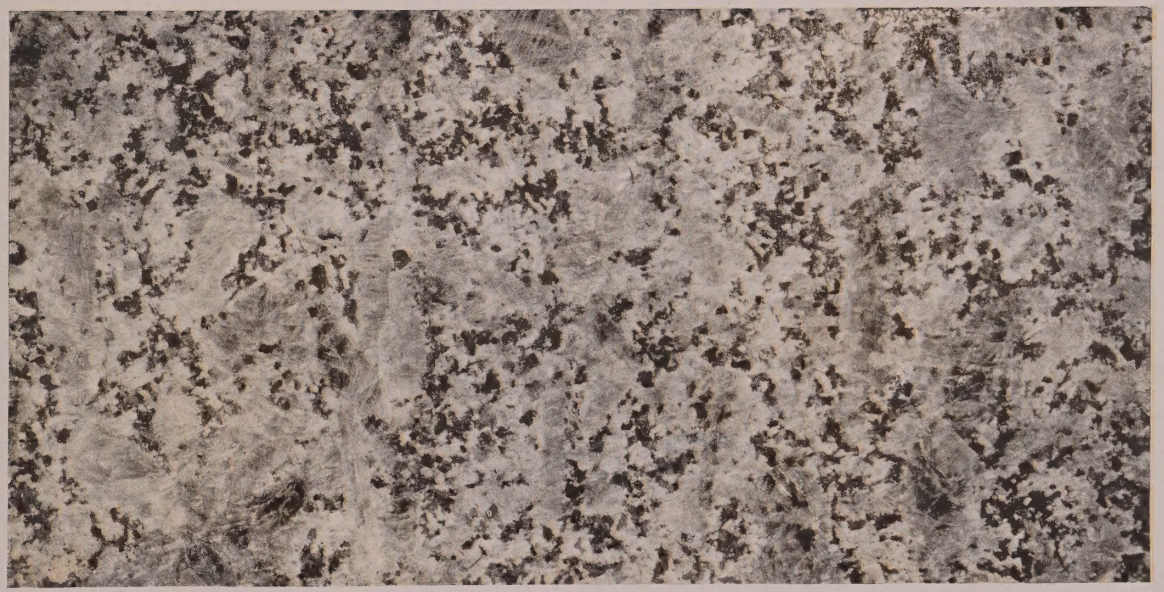
It is a coarse-grained, well marked material, with a good colour, and looks well either polished or unpolished.

YASS, N.S.W.—The granite area of this district is large, and runs generally north and south, intruding into slates, shales, and limestones. Between Murrumbateman and the Murrumbidgee there runs for several miles north and south a belt of unknown width of stratified granite. It is a splendid stone for building purposes, easily worked and easily quarried, because it is in large slabs, weighing from a few pounds to a few tons, standing on end.

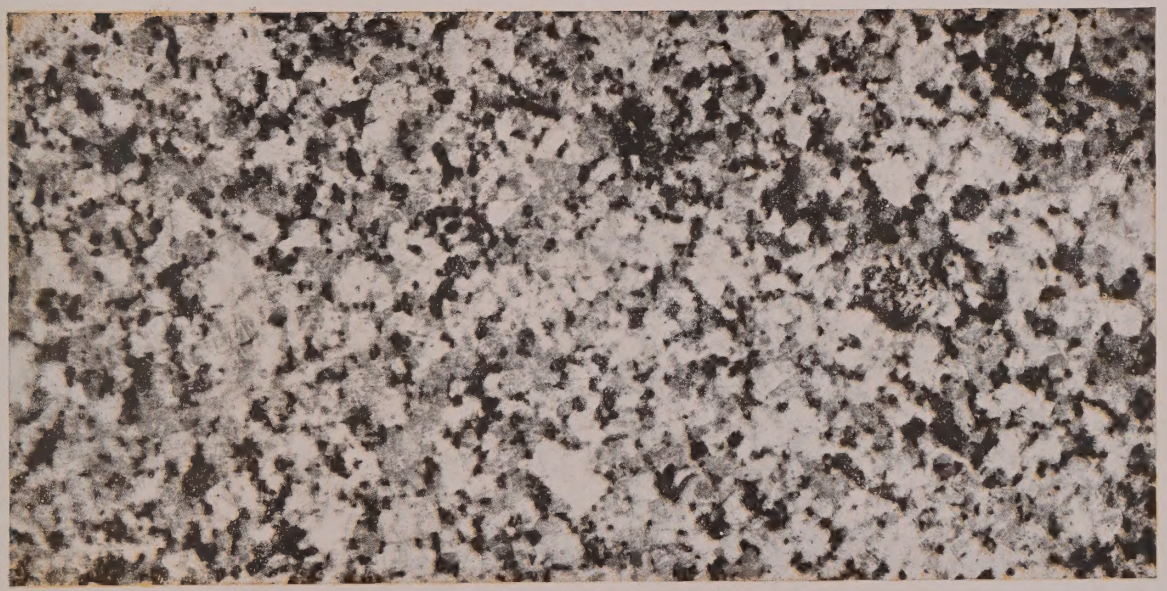
YOUNG, N.S.W.—This rock covers a large area, extending from Harden to within a short distance of Grenfell, with very little alteration in nature. Churches and private residences in Young are built of it, and the abundance of biotite seems in no way to detract from its durability.



URALLA GRANITE, N.S.W. *Nat. Size.*



MONTAGUE ISLAND GRANITE, N.S.W. *Nat. Size.*



MORUYA GRANITE, N.S.W. *Nat. Size.*

C F.L. Photo.

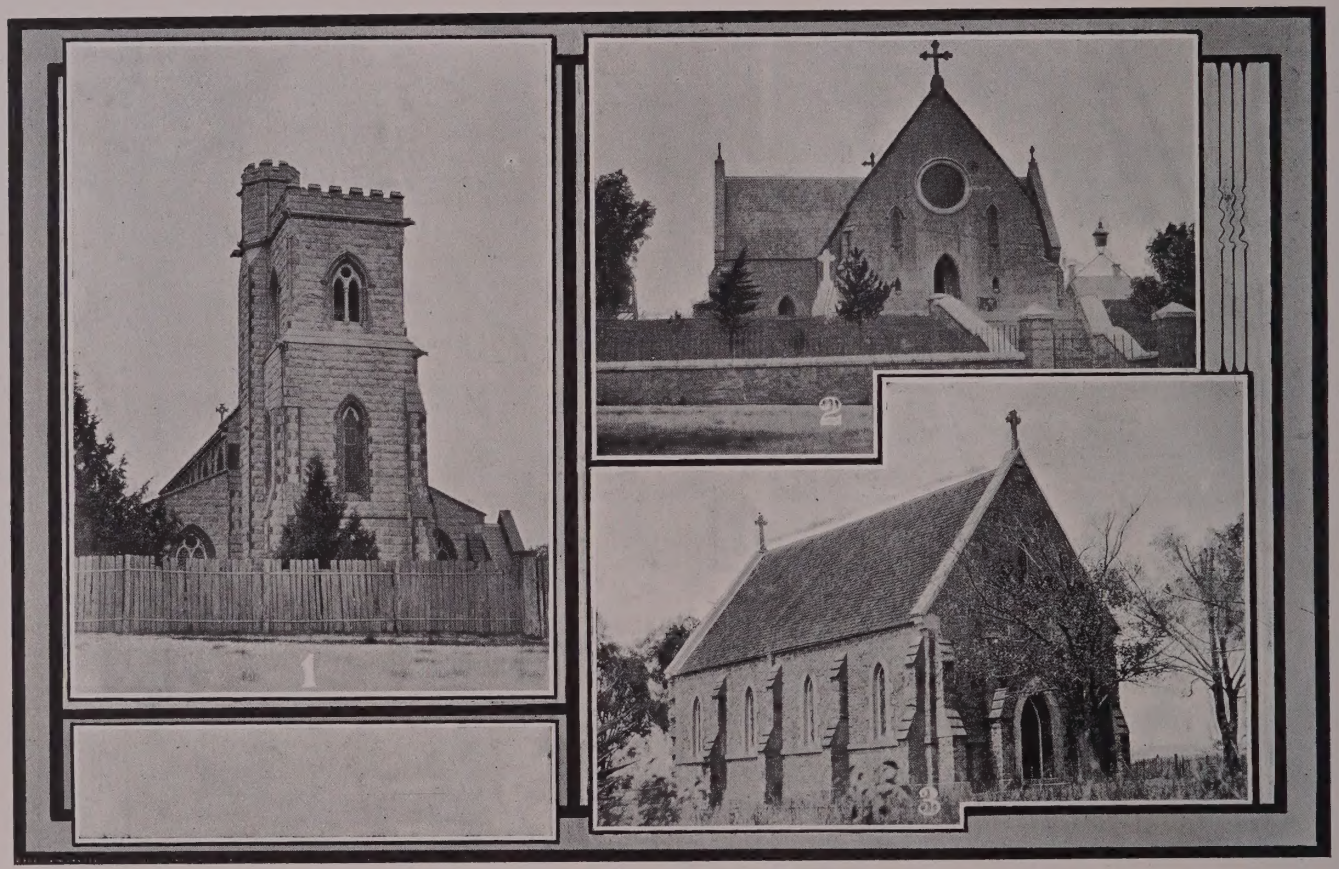
GREY GRANITE.

(ROMAN CATHOLIC CHURCH AT YOUNG.)

C.F.L. Photo

GREY GRANITE.

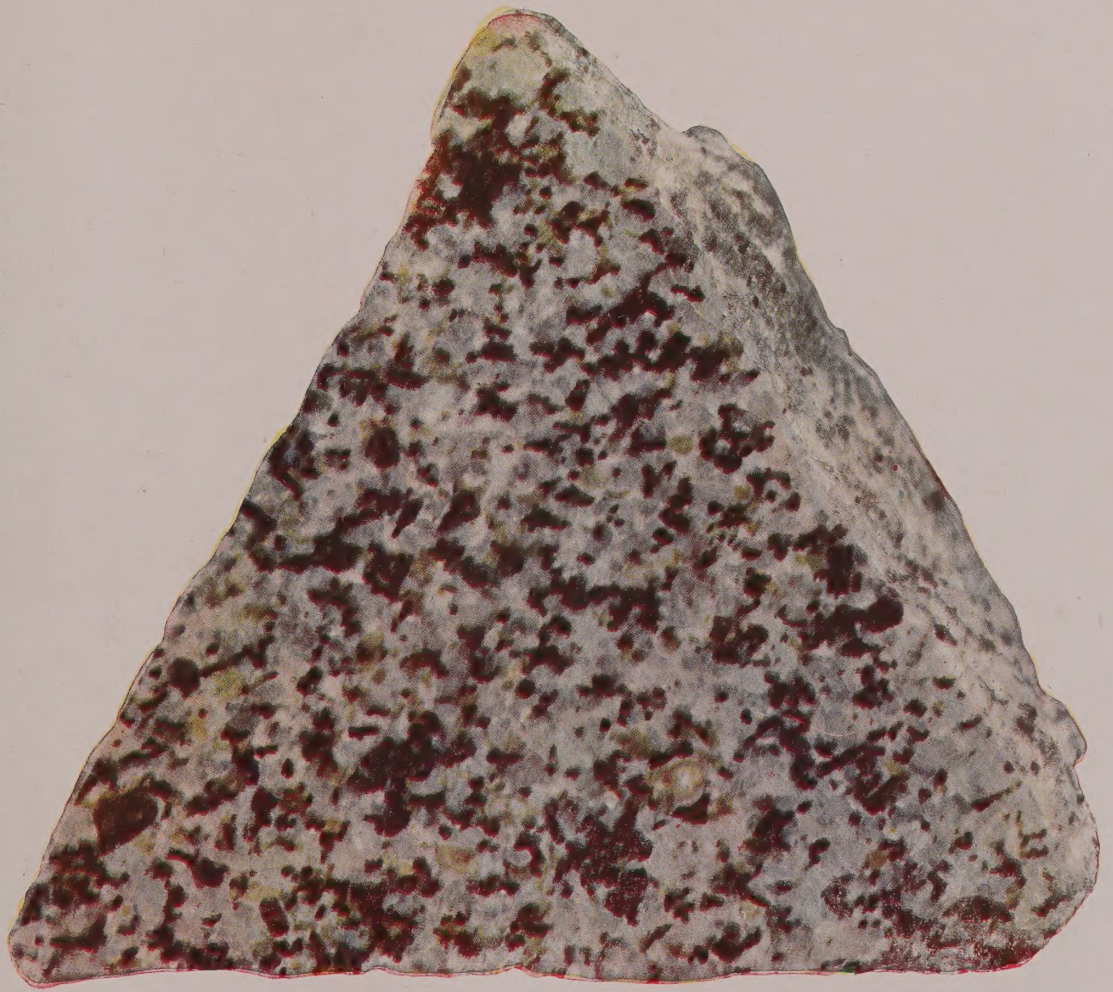
(COWRA CONVENT.)



1. GRANITE.
(CHURCH OF ENGLAND, BRAIDWOOD.)

2. GRANITE.
(ROMAN CATHOLIC CHURCH, BRAIDWOOD.)

3. GRANITE.
(CHURCH OF ENGLAND, GUNNING.)



Nat. Size

GREY GRANITE, YOUNG, N S.W

ALBURY DARK GRANITE, N.S.W.

Nat. Size.

(c) Green Granites.

Under this heading come varieties of granite which can hardly be classified as either grey or red. The colour is variegated, green predominating, due to the abundance of green felspar intermixed with pink.

ALBURY, N.S.W.—The plate of this dark granite well illustrates the distinguishing characters of this beautiful granite.

BRAIDWOOD AND BUNGENDORE, N.S.W.—Specimens of this particular stone also occur near these towns.

II.—Gneiss.

In addition to the localities given from New South Wales, there are enormous masses of Gneiss in some of the other States, notably South Australia and the West Coast of Tasmania, but their possibility as building stones has not yet been investigated.

ADELONG, N.S.W.—A handsome hornblende Gneiss occurs in enormous quantities in this neighbourhood, but has not yet been quarried to any extent.

BUNGENDORE, N.S.W.—There are unlimited quantities of this material available for building purposes. It is known locally as granite, and has been used in many buildings in Bungendore.

The matrix is a buff or yellowish colour with streaks of black, and is not unpleasant when polished; in fact, looks like some varieties of marble.

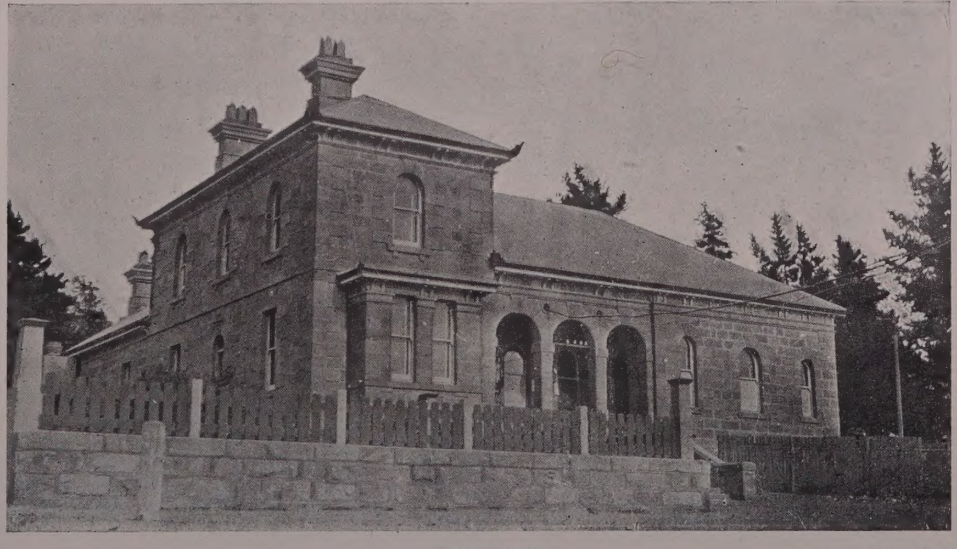
COOMA, N.S.W.—Gneiss is the chief rock in the Cooma District, and has been largely used in the construction of buildings within the town. The rock at first appearance is not unlike granite, and is dark-grey in colour, consisting chiefly of quartz, felspar, and abundant black mica (biotite). The schistose structure is not as a rule visible in small specimens and imparts but a slight grain to the stone, which is easily quarried and worked. There is an unlimited quantity available.

POMEROY, near Goulburn, N.S.W.—A grey material of this character occurs in the locality.

GNEISS.

(COURT HOUSE COOMA, N.S.W.)

C.F.L. Photo.



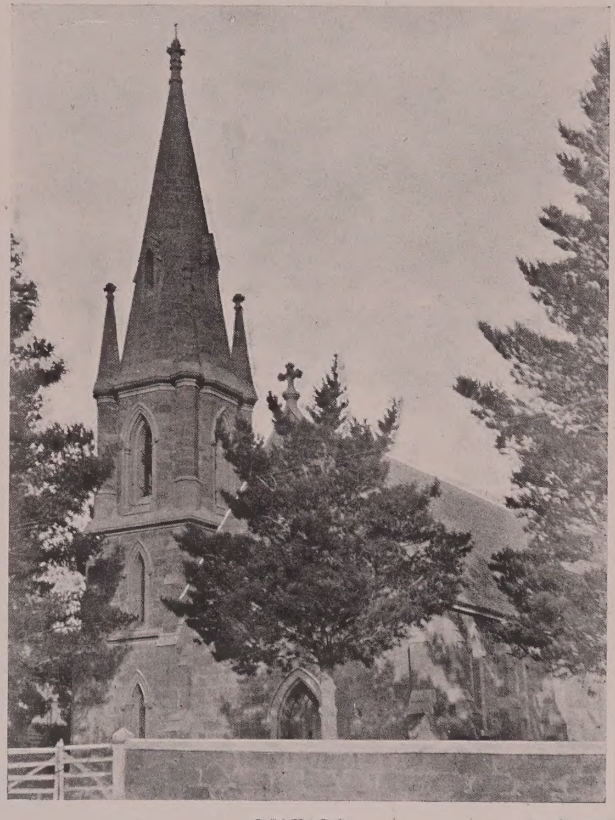
GNEISS.

(POST OFFICE AT COOMA, N.S.W.)

C.F.L. Photo.

GNEISS.

(CHURCH OF ENGLAND, BUNGENDORE, N.S.W.)



GNEISS. *C.F.L. Photo*

(CHURCH OF ENGLAND, COOMA, N.S.W.)

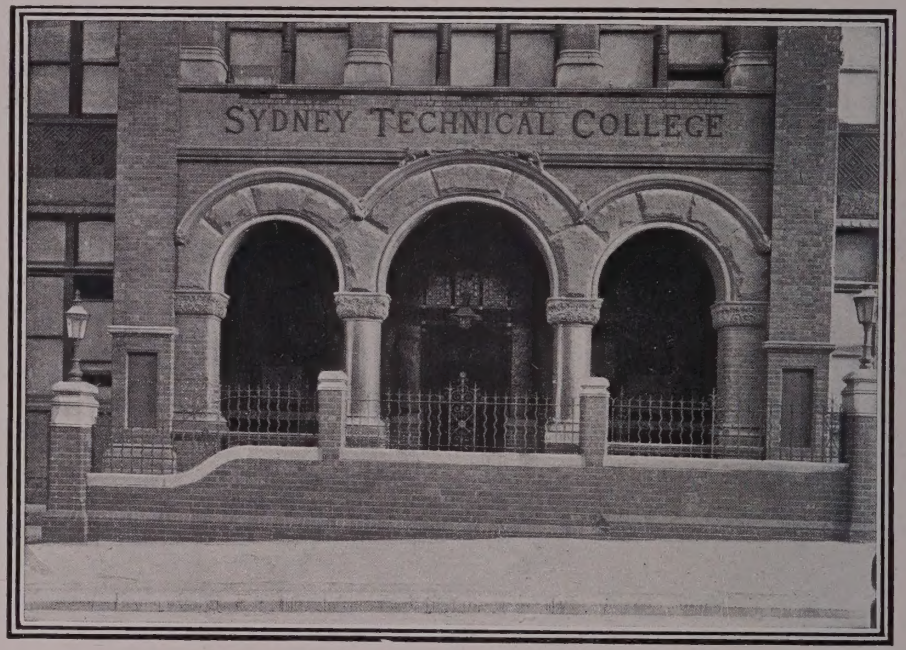
III.—Trachyte.

BOWRAL, N.S.W.—The building and ornamental stone passing under this name is a favourite one with Sydney architects. There appears to be some doubt as to its true petrological classification, being regarded by some as a Syenite (Bostonite), but probably its systematic position will be found to lie between these two classes of stones.

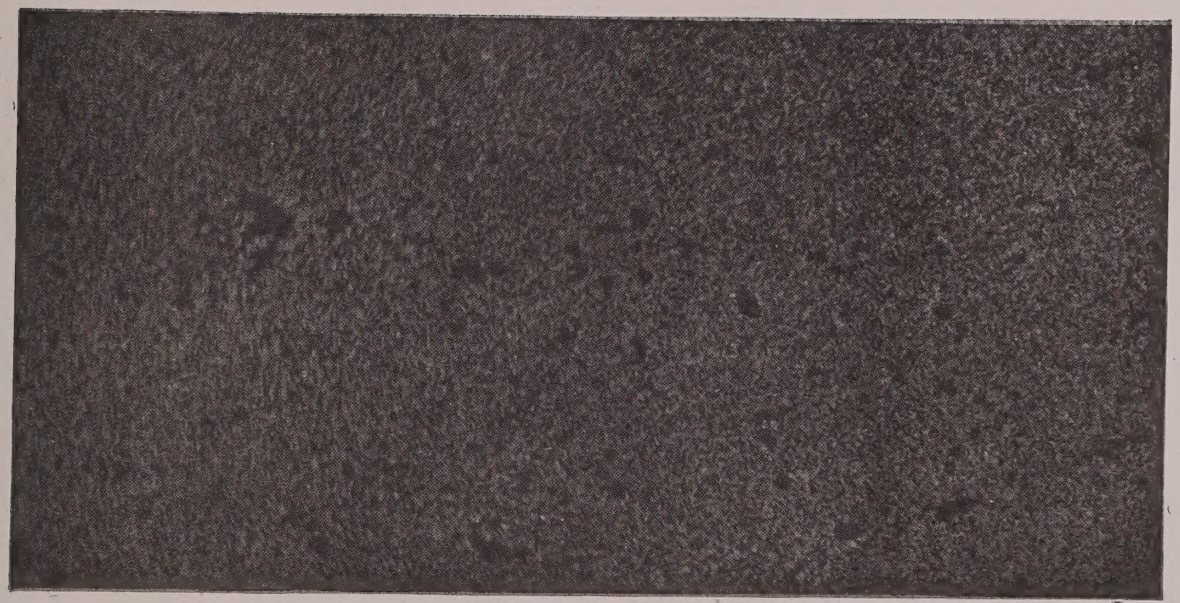
It is known commercially as "Bowral trachyte," and so that is the name retained for it here.

This igneous rock has been principally worked at a bold headland about 85 miles from Sydney on the Southern Line and known as the "Gib," which is close to the town of Bowral.

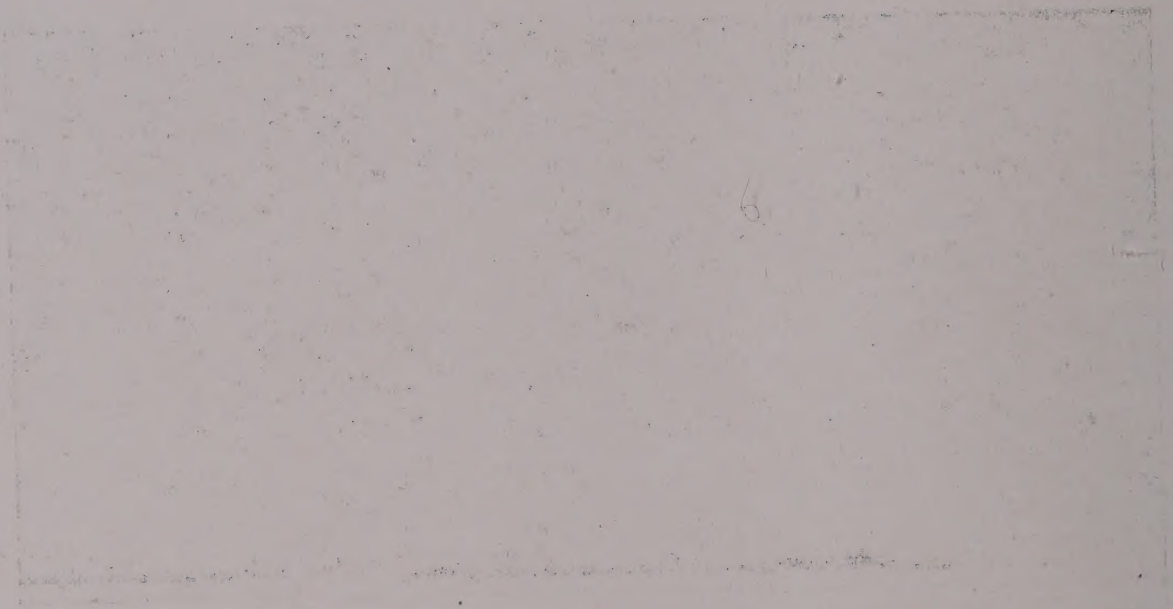
This really beautiful stone of unique colour, which may be described as a dark olive green, or, perhaps dark grey, is occasionally streaked with narrow veins containing beautiful sanidine (glassy orthoclase), hornblende, and ægerine crystals.



BOWRAL TRACHYTE COLUMNS AND ARCHES.
(TECHNICAL COLLEGE, SYDNEY, N.S.W.)



BOWRAL TRACHYTE, N.S.W. *Fat. Size.*



It is very solid and takes a beautiful polish, cracks or flaws being quite absent, and blocks of almost any size can be obtained. Some of the finest architectural structures in Sydney are built of this rock.

As a paving stone it is highly valued, being equal to the famous Caithness, Arbroath, and Yorkshire flagging, and is also eminently useful for foundation work.

Its weight-carrying capacity is equal to most of the known granites.

Amongst the most prominent edifices in Sydney constructed from this material are the Equitable Life of New York, Mutual Life of New York, Challis House, Technical College, Bank of Australasia, &c. It has also been used in the piers of the Hawkesbury Bridge, and in the foundations only of many of the largest buildings in Sydney.

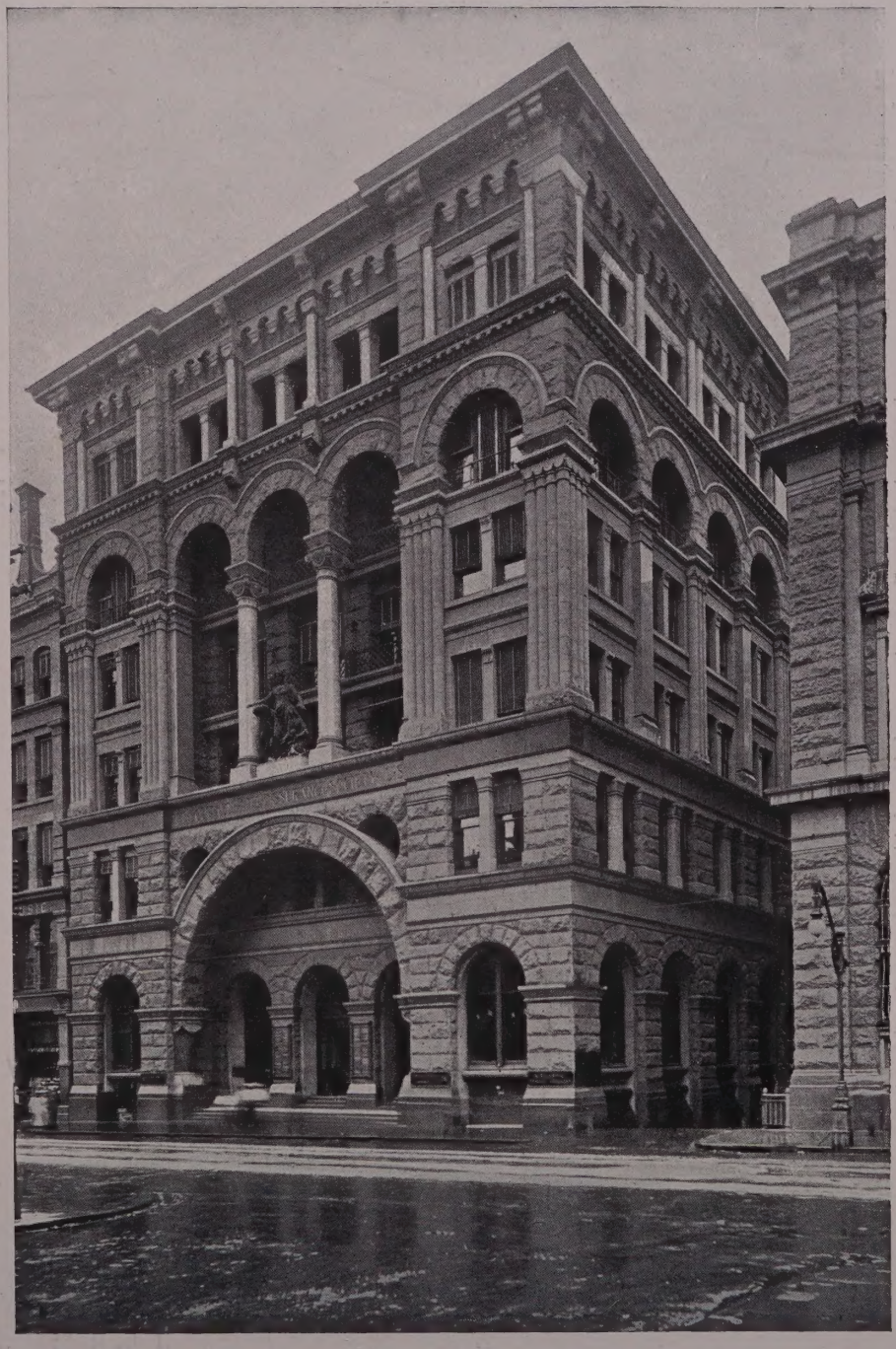
In both the polished and unpolished condition it gives an appearance of solidity in buildings that is quite attractive and pleasing.

ORANGE, N.S.W.—Near this town are large flows of true Trachyte, composing the bulk of the mountain known as the Canoblas.

As a building stone this Trachyte is in great repute amongst local builders, as it is very hard, durable, and polishes a soft grey or buff base colour, with small pink and black spots, producing a very nice figure, and is altogether a very neat-looking material.

It makes a good flagging stone, and is used as such in front of the most important buildings in Orange.

BOWRAL TRACHYTE, HAWKESBURY SANDSTONE.
(SYDNEY, N.S.W.)



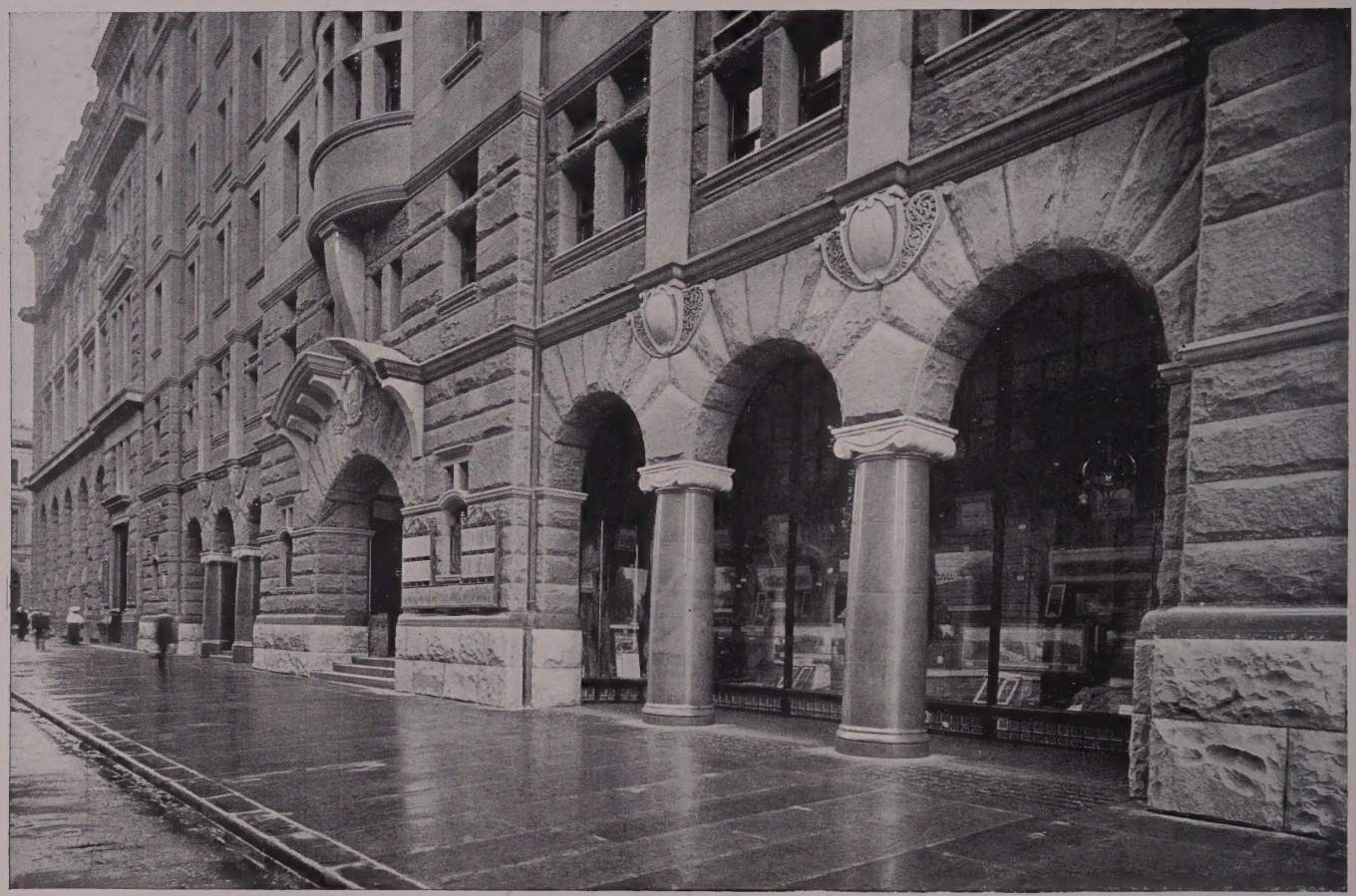
BOWRAL TRACHYTE.

(EQUITABLE BUILDING, SYDNEY, N.S.W.)

CANOBLAS TRACHYTE, N S.W.

Nat. Size.

PIERS
OF
BOWRAL
TRACHYTE.
(HAWKESBURY
RIVER BRIDGE,
N.S.W.)



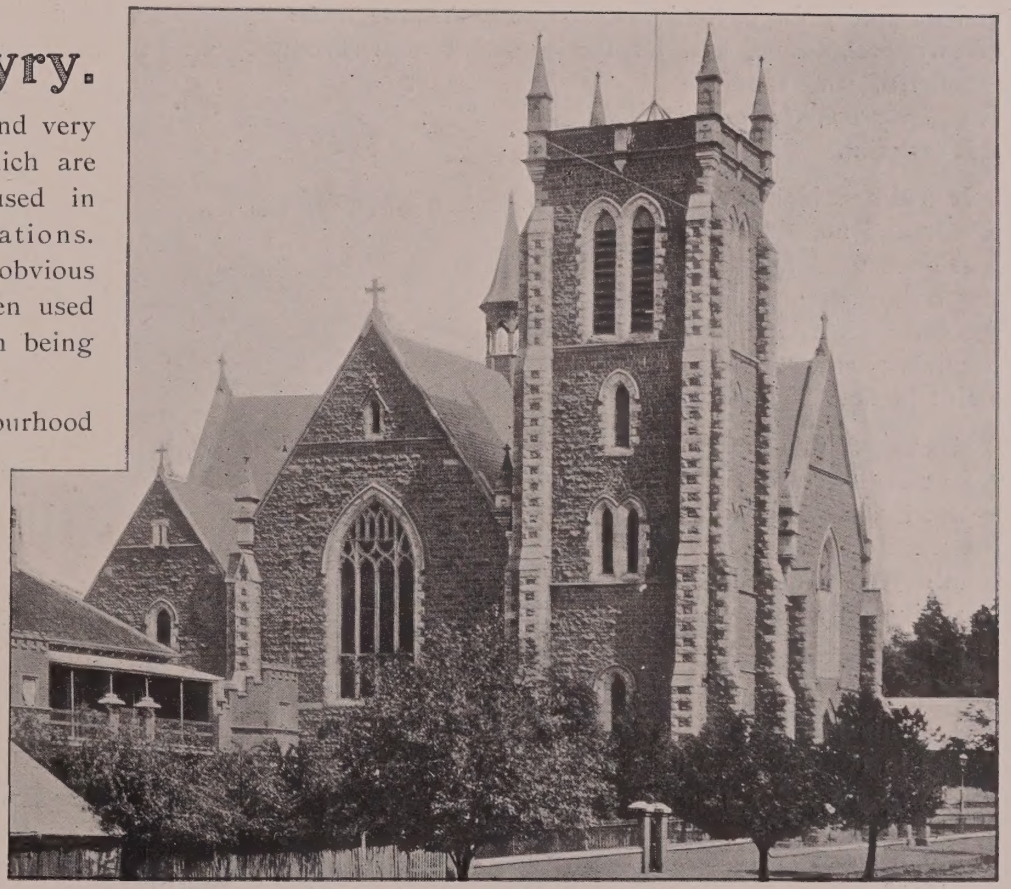
COLUMNS, FLAGGING, AND BASE-COURSES OF BOWRAL TRACHYTE
(INTELLIGENCE DEPARTMENT, N.S.W.)

IV.—Porphyry.

THIS is a group of hard and very fine ornamental rocks, which are destined to be greatly used in future for internal decorations. At present, however, for obvious reasons, they have not been used extensively, their utilisation being of a local nature.

There is in the neighbourhood of Goulburn a large deposit of this rock.

It takes a beautiful olive-green polish; in fact, is similar in colour to Serpentine, which stone it certainly should supersede in building construction, for whilst having all the beautiful effects of that material, yet possesses hardness

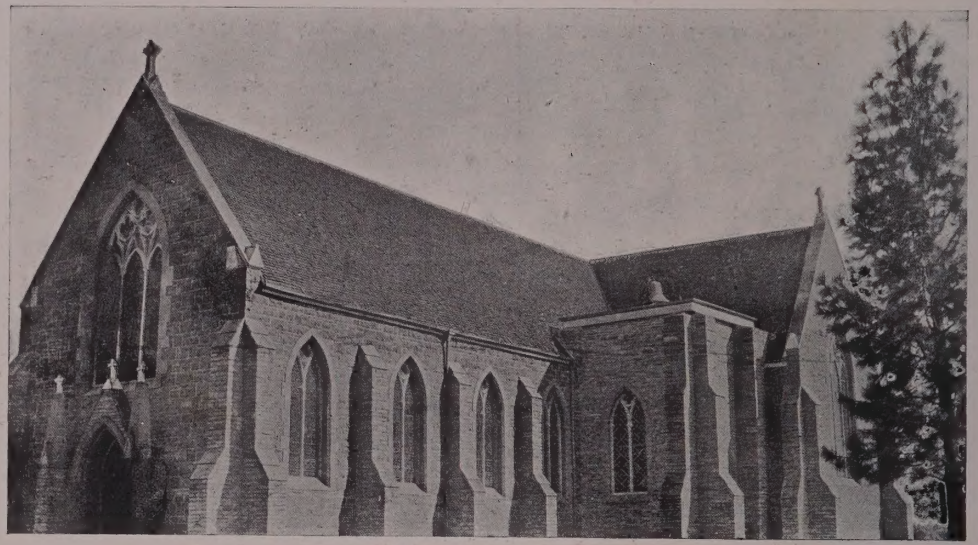


GOULBURN PORPHYRY.
(ST. PETER'S AND ST. PAUL'S CATHEDRAL GOULBURN, N.S.W.)

and durability far beyond that ornate stone. It looks well either polished or unpolished in buildings of any pretensions, and its qualities are well brought out in SS. Peter and Paul's Cathedral at Goulburn, which edifice is entirely constructed of this material.

It is almost identical in colour and marking with a Diorite used in building construction in Minnesota, U.S.A., and occurring at Addison Point in that State.

Rocks of this nature are exceedingly well developed in the south-eastern plateau of New South Wales, and of necessity only a few of the many and distinct types can be tabulated.



QUARTZ PORPHYRY. *C.F.L. Photo.*

(ROMAN CATHOLIC CHURCH, BURROWA, N.S.W.)

This stone could be looked for in almost any portion of the Southern Table land of New South Wales in conjunction with Silurian and Devonian rocks.

BREDBO, N.S.W.—A light-coloured quartz porphyry, with a pale bluish-grey base, outcrops immediately to the east of Bredbo. It should take a good polish.

BURROWA, N.S.W.—Dark quartz porphyries, similar to those at Yass, are abundant near the town, and are used in the construction of churches and other buildings.

GOULBURN GREEN PORYPHRY, N.S.W.

Nat. Size

CANBERRA, N.S.W.—There is a rather plentiful supply of this dark, almost black rock, which splits easily with a slightly flinty fracture.

It has been used in part in the Canberra Church.

COWRA, N.S.W.—It occurs here over a large area; this material having a dark-green base, with white or coloured crystals of felspar scattered throughout. (*E. F. Pittman.*)

CURRAWONG, N.S.W.—Here occurs a small outcrop of felspar porphyry.

GAWLER RANGES, S.A.—A large outcrop of felspar porphyry is found in these ranges. It has a fine dark red base with black markings. Owing to its hardness it could only be used commercially in small columns such as seen at Cathedral entrances and Public Buildings. Its high colour assures its decorativeness.

GOULBURN, N.S.W.—A handsome dark-green rock, which may be systematically classed as a porphyrite, has been worked in the vicinity, and used extensively for the construction of buildings within the town.

HALL, N.S.W.—Quartz porphyry occurs here, similar to that at Canberra. The church is built of this rock. It outcrops at intervals right throughout the district.

MICHELAGO, N.S.W.—Quartz felspar porphyry outcrops in the range of hills lying between the township and the Murrumbidgee River. The rock has a grey base, with abundance of white felspar, and sometimes approaches very near a granite in texture.

Michelago, N.S.W.—*contd.*

Another variety occurs on the opposite side of this range. It is fine-grained, with abundant small crystals of pink orthoclase.

A green quartz felspar porphyry, with the red felspars occurring in patches or segregations, is found near the Murrumbidgee River. It takes a good polish, and commercially might be classed with the green and variegated granites.

MURRUMBATEMAN, N.S.W.—To the west of the town is found a stone which has been called "stratified granite" but is in reality a quartz porphyry, similar to the other rocks of that type in the district. (*Vide* "Grey Granite," Yass.)

URIARRA, N.S.W.—A very fine-grained quartz felspar porphyry is found near the Post Office. The base is dark, and there is an abundance of fine pink orthoclase.

A rock with a chocolate base, in which are embedded numerous white felspar and quartz crystals, outcrops on the Murrumbidgee River, below its junction with the Uriarra to Queanbeyan road.

YASS, N.S.W.—The hills surrounding this town are composed of this material, so that the supply is equal to all demands for a long time.

The base is a dark olive green, in which are numerous white, well-defined felspar crystals along with abundant clear glassy quartz, speckled with larger masses of green hornblende.

So far it is unworked, owing perhaps to its hardness—a quality that would be compensated by its durability.

V.—Diorite.

THIS is a material often with a good colour, but is not frequently favoured by architects owing to its hardness, and hence its high cost of preparation for the builder.

BUMBALDRY, N.S.W.—An even-grained, bright-coloured diorite outcrops in large quantities about 3 miles eastward from Bumbaldry. In appearance this rock is very similar to some of the better classes of grey granite.

GOULBURN, N.S.W.—A fine-grained, dark-coloured diorite is extensively developed in this district. The rock, which takes a good polish, has been largely used in the construction of local buildings.

JERANGLE, N.S.W.—A fine-grained dark diorite, very hard and tough, occurs as belts or dykes, up to 20 yards across, cutting through the granite of the locality.

TARAGO, N.S.W.—A fine-grained green diorite occurs about 14 miles beyond this town in the direction of Braidwood. The predominant minerals are black hornblende and a pale-green felspar (plagioclase), which being in about the same quantities produce an even texture.

TUMUT, N.S.W.—This material occurs in abundance in the hill immediately to the south of the town. It is a peculiar rock, dark in colour, but very uneven in texture; coarse patches occur at intervals through the matrix, consisting of lath-shaped white felspar crystals. It is very tough, and hard to work, and may be classified systematically as intermediate between a true diorite and porphyrite. It takes a good polish.

STRINGER'S CREEK, Vic.—This is a dark-coloured, fine-grained stone.

WALHALLA, Vic.—A fine and also a coarse grey variety of this material are recorded from this neighbourhood, but have so far not been used.

WEE JASPER, N.S.W.—The tops of the ranges south of Wee Jasper, on the Tumut Road, are composed of this hard, tough material.

VI.—Basalt.

THIS material is fairly common throughout the Eastern States, showing in its distribution material of varying textures, from very fine to coarse and vesicular, and all varieties have been used to a more or less extent in architecture in Victoria, and even in New South Wales and Queensland.

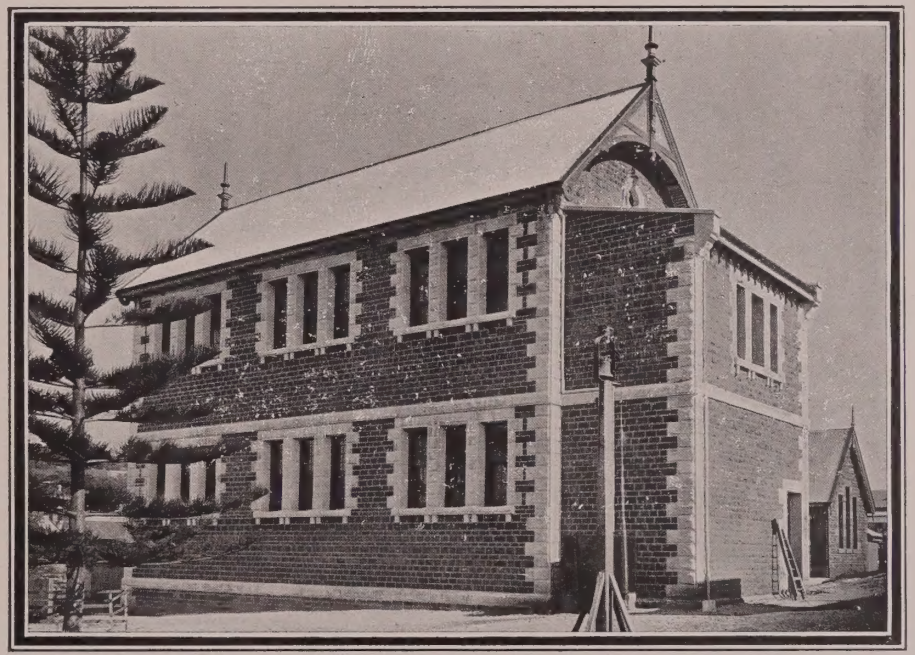
In Victoria, the steps of Parliament House and most of the base courses to all the large public and business premises in Melbourne are constructed of "Footscray Blue Metal," or Blue Stone, as it is commonly known.

St. Patrick's Cathedral is entirely constructed of it externally.

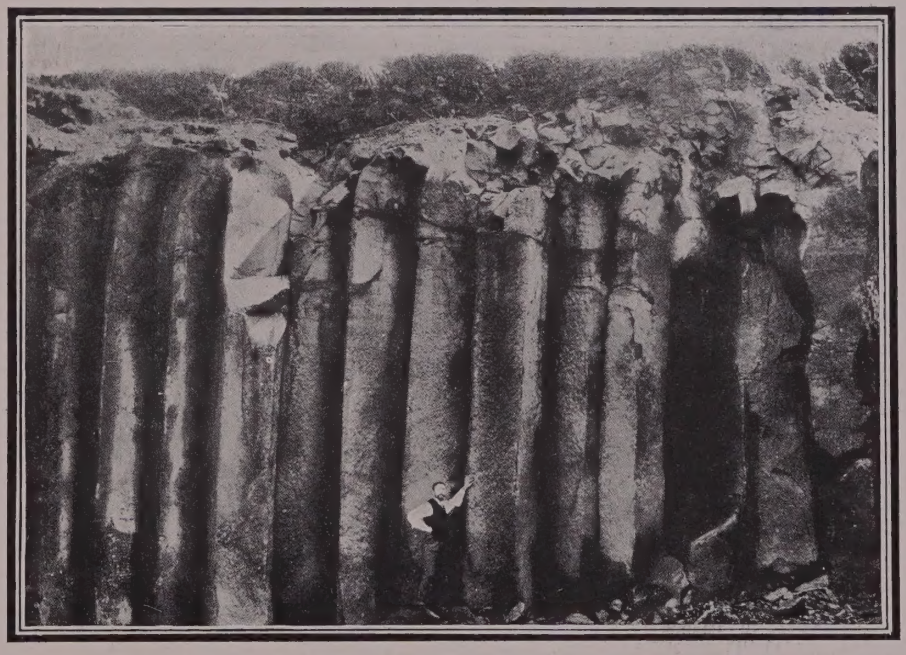
It is, however, now being discarded for everything but base courses and foundations, as being too funereal in its appearance.

In Victoria the largest quarries are at Footscray.

Basalt is also extensively



KIAMA BASALT.
(PUBLIC SCHOOL KIAMA, N.S.W.)



BASALT QUARRY, ORANGE, NEW SOUTH WALES.

BASALT QUARRY, KIAMA, NEW SOUTH WALES.

used for road-making and ballast for railways, as well as for building purposes. It is hard, heavy, breaking comparatively easily, and very durable, and is known commercially as "blue metal."

It is found as a volcanic outcrop in many places in New South Wales on the Main Dividing Range and Coast, and has been extensively quarried at Kiama and Dundas.

There is also an extensive deposit at Orange of a fine-grained material, which splits readily into well-formed blocks. It is very hard and takes an excellent polish, which gives it a dark shade of green.

INVERELL BASALT.
(STORE, INVERELL.)

At Sterling, 9 miles from Inverell, a columnar basalt is quarried and used in the construction of business houses at the latter town. Extensive ancient lava flows of this material cover the granite of the New England tableland in many places. At Uralla they have been quarried for road metal, and the deposits at Sterling, Armidale, and many other localities are of this nature.

At Jerangle this rock is abundant, and is known locally as Whinstone.

FOOTSCRAY BASALT.

(ST. PATRICK'S CATHEDRAL, MELBOURNE.)

VII.—Dolerite.

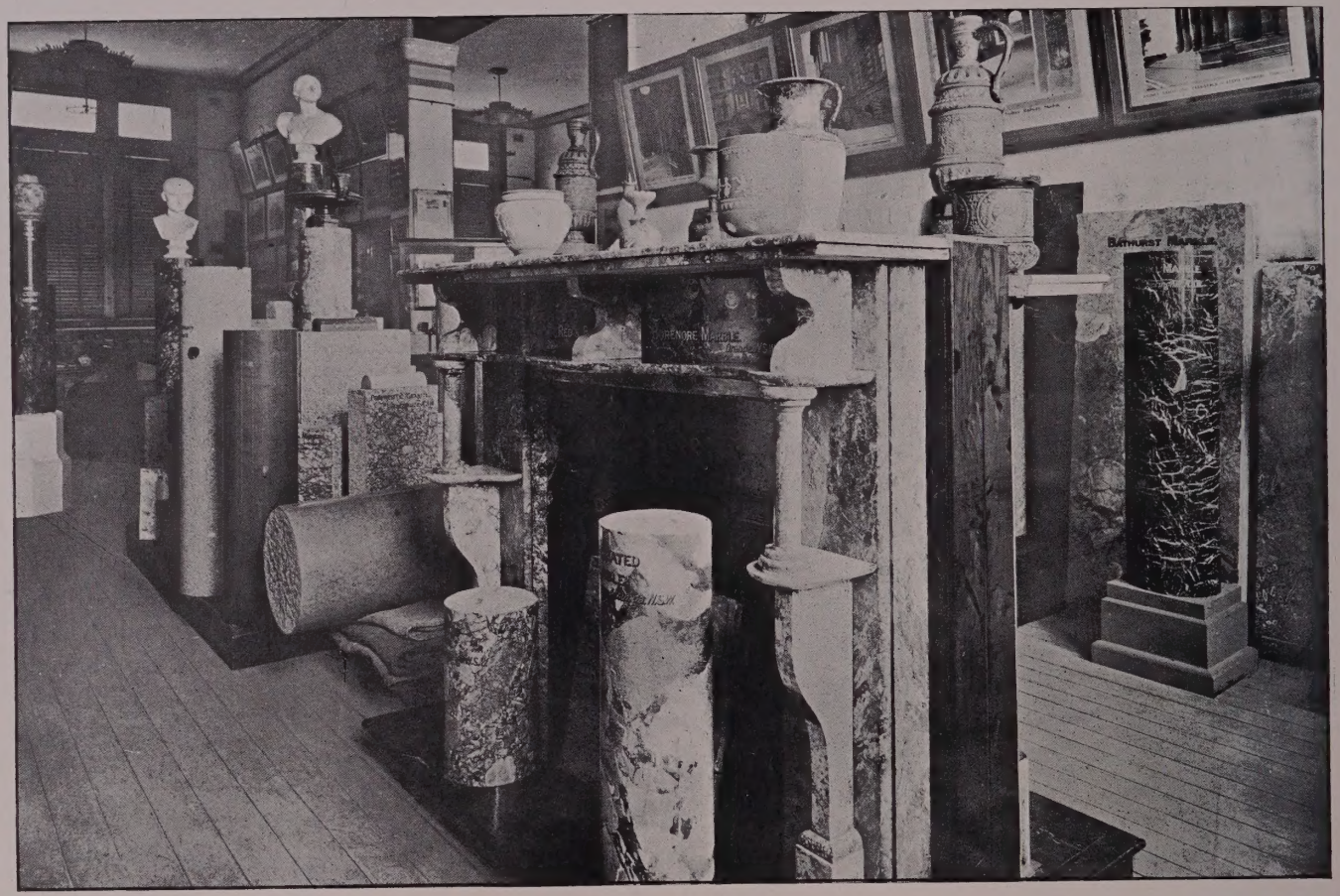
THERE is a large intrusive mass, probably a laccolith, of this material at Prospect, near Sydnev. It has been extensively quarried for use in the construction of the Prospect Dam. Its rank as a building stone is unknown, although it is most durable in the form of steps, as it does not wear smooth nor take a high polish.

VIII.—Marbles.

MARBLE probably ranks as the most extensively distributed and valuable of all the building material found on this continent, and in her marbles Australia has a very fine and valuable national asset, which may be said to be inexhaustible. In fact, the value of these is beyond computation, and it is doubtful if any other country is so rich not only in amount but in variety of material lying ready for utilisation.

Although practically only the surface has been worked, yet indications seem to point to such commercial possibilities that every desideratum in marble products could probably be supplied. The most populous States have, of course, opened out the most quarries, and so naturally New South Wales shows a range of various kinds that are probably not surpassed by any other State or, one might even add, that of any other country.

Almost every conceivable colour and texture are to be found in the marbles of this State, and possibly similar terms will be used when speaking of those of other political divisions of the Commonwealth in the future, when they have been more fully developed. The Australian marbles, besides being inexhaustible, are of varied and beautiful colours, and in addition possess all the other qualities that pertain to first-class marbles, and so are of great commercial value.



NEW SOUTH WALES MARBLE EXHIBITS.
(TECHNOLOGICAL MUSEUM.)

Next to New South Wales, South Australia has given most attention to her marbles, and has worked some of the quarries for a long period, but lack of population has militated against greater development of this commodity. However, within the last few years a fresh impetus seems to have set in, and the marble industry promises to take new life.

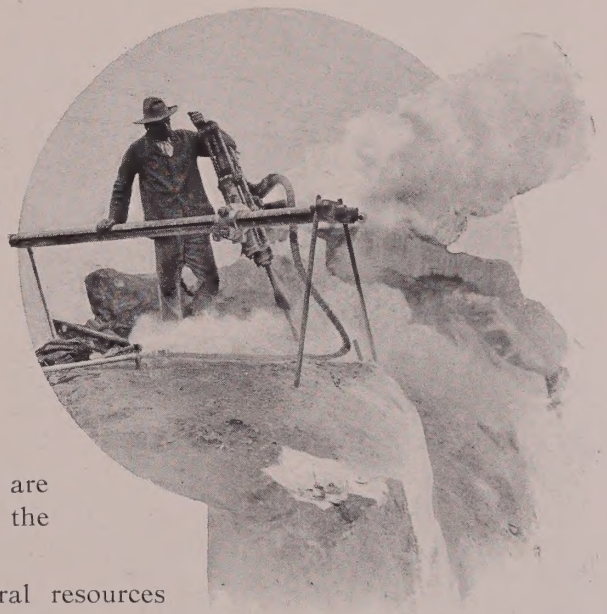
The occurrence of marbles in Victoria has long been known, but only within the last year or two has any move been made to develop them. The specimens obtained from various parts of the State give indications of some very fair stones, but at present all are found in localities remote from centres of population, and hence are costly both to produce and transport, and so are at a disadvantage compared with those of the neighbouring States.

In addition to those marbles of Victoria given below, others are also recorded from Keiler, Waurn Ponds, Geelding, Bat Ridge, Hope's Mill, but these are all lifeless and of no distinctive colour, and not of any commercial value.

In most cases in New South Wales, the stones are on, or near, direct lines of railway, or seaboard, to the Capital—Sydney, and other large towns.

Queensland is rich in marbles, and as its mineral resources become better known and population increases, these will be largely used for building purposes.

Our knowledge of the building and ornamental stones of Western Australia is at present very limited, but as the country becomes opened



DRILLING.
(CALOOLA)

(*a*) FINE. (*b*) COARSE

ATTUNGA BRECCIATED MARBLE COLUMNS.

out and settled, no doubt material comparable with that from Eastern Australia will be brought to light.

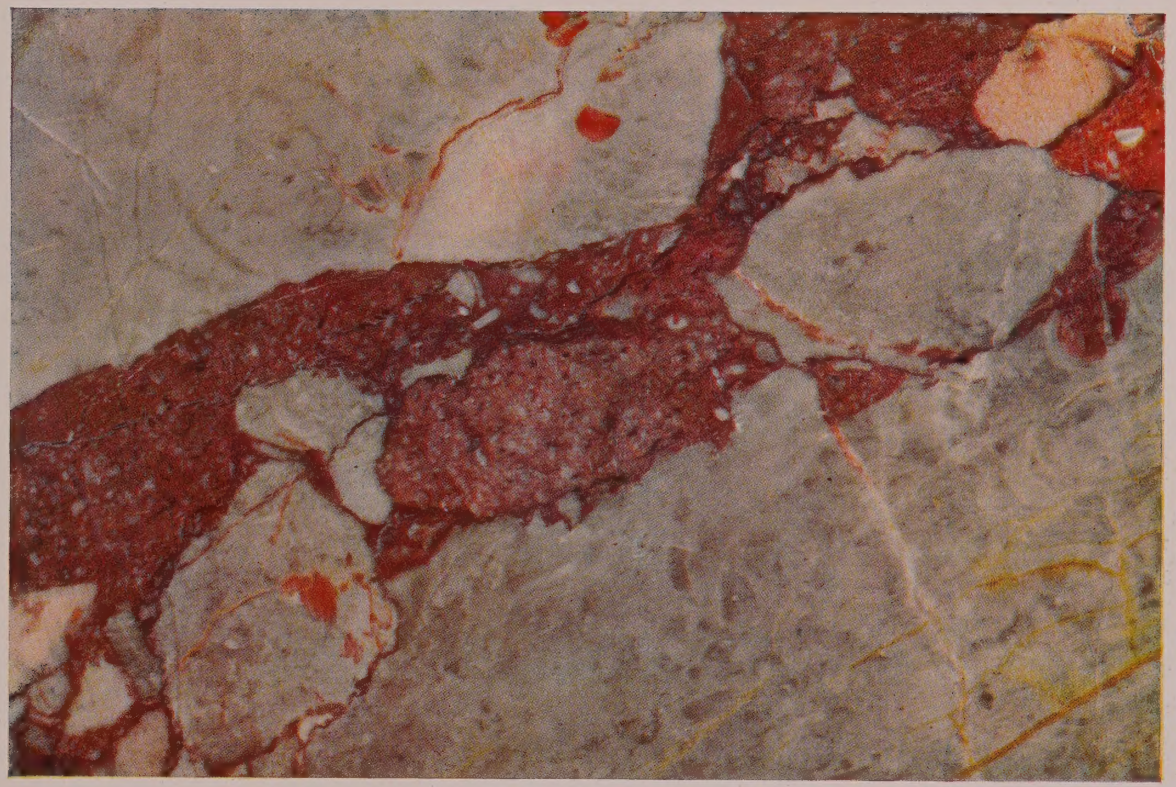
For obvious reasons only a comparatively limited number of quarries are being worked in Australia, but an increased demand will alter this, as there is little difficulty in procuring the material, which is close to the surface.

Necessarily, working on what is practically surface stone, the best has yet to be quarried, for the deeper the quarries are opened out the better the material will become, being less fractured and of purer quality, as obtains in some of the old Italian, Greek, and Egyptian quarries which have been worked for hundreds of years.

Although practically the industry is only at its inception, yet specimens now exhibited at London and this Museum demonstrate that a great commercial future is before it.

The varied colours of these marbles are found to blend, harmonise, or contrast in the specimens from the different localities, and in a manner that give each a distinctive character in its beautiful figures and beautiful effect.

With such results, obtained from only a few



ATTUNGA MARBLE, N.S.W.

years prospecting, it is not unreasonable to expect that still greater returns await further development of these remarkable marbles.

The specimens exhibited at the Franco-British Exhibition were from Borenore, Caloola, Fernbrook, Kempsey, Narrabri, Springhill, and Tamworth quarries, these being the more important ones worked at that time.

The following are known localities for marbles of excellent quality :—

ABERCROMBIE CAVES, N.S.W.—A very pale-coloured marble, almost pure white, except for a few brownish-red markings.

ADELONG, N.S.W.—An attractive white stone, mixed with a moderately dark green colour. It should look handsome in columns and in decorations.

ANGASTON, S.A.—

(*a*) *White.*—A coarse-grained saccharine marble, varying in cream and white tints, and in some cases with dark markings similar to those found in Silician. When dressed it has a translucent effect on the edges and face.

It is used in monumental work with good effect, having the general facies of the material of which the famous Elgin marbles are made.

(*b*) *Pink.*—A somewhat similar marble to (*a*) in texture, with a shade of pink.

ATTUNGA, N.S.W.—This is one of our most handsome marbles, being composed of large pale-coloured fragments embedded in a red groundmass. It varies much in texture, the coarser varieties frequently consisting of fragments up to 1 foot or more in diameter, with well-defined edges. It looks magnificent when polished on a large scale, and is so illustrated by columns in this Museum. As a brecciated marble it probably has no superior anywhere.

Attunga, N.S.W.—*contd.*

BATHURST. *Vide* **LIMEKILNS.**

BIBBENLUKE, N.S.W.—A crinoidal black and white marble.

BINALONG, N.S.W.—A deposit outcrops near the railway line west of the Binalong railway station. A sage-green colour characterises the whole mass, though there is a paler-coloured variety with brown and green tinges throughout.

Our attention was drawn to this green-coloured marble by Mr. F. Rusconi, of Gundagai.

BINGERA, N.S.W.—This is a continuation of the Warialda deposit, and is as yet unworked. Several varieties of variegated and brecciated marbles occur here. The outcrop of this belt of marble continues to the southwards, being in evidence at

MURAL DECORATIONS—BORENORE MARBLE, N.S.W.

COUNCIL CHAMBERS, MELBOURNE.

Half Nat. Size.

BATHURST MARBLE, N.S.W.

Half Nat. Size.

BATHURST MARBLE N.S.W.

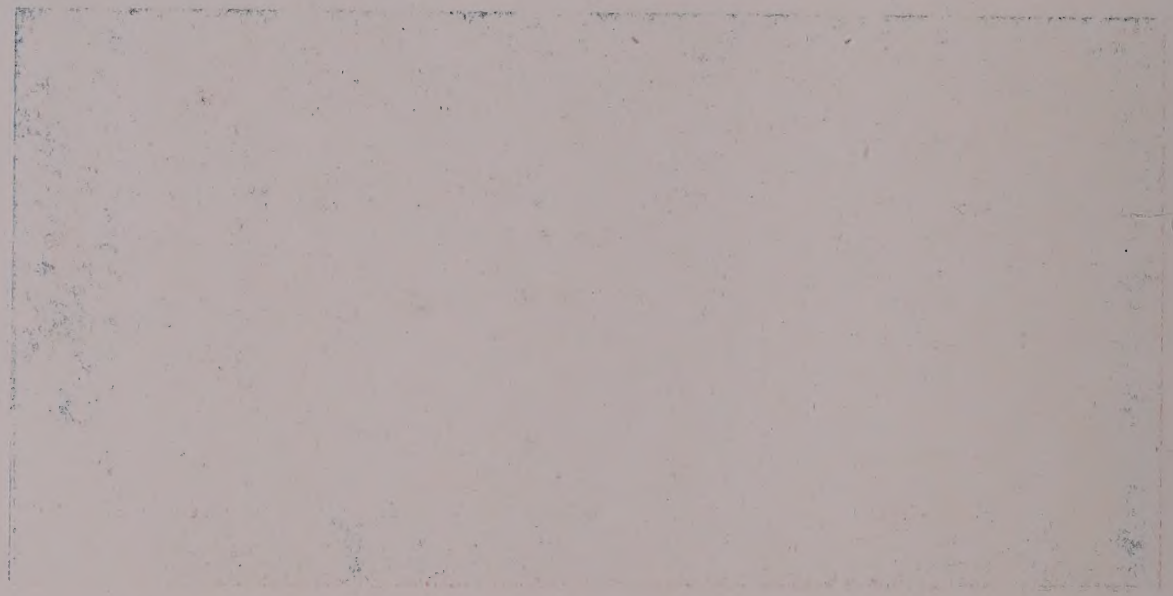
LIME KILNS MARBLE, BATHURST, N.S.W.

Half Nat. Size.

Half Nat. Size.

LIME KILNS MARBLE, BATHURST.

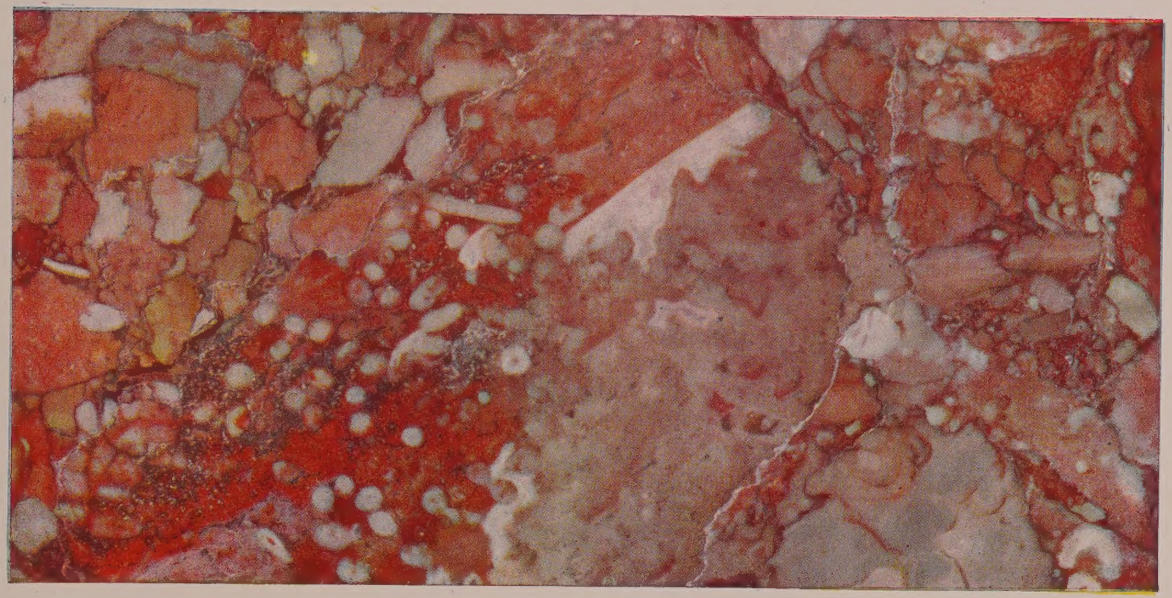
N.S.W.



BINALONG GREEN MARBLE, N.S.W. *Nat. Size.*

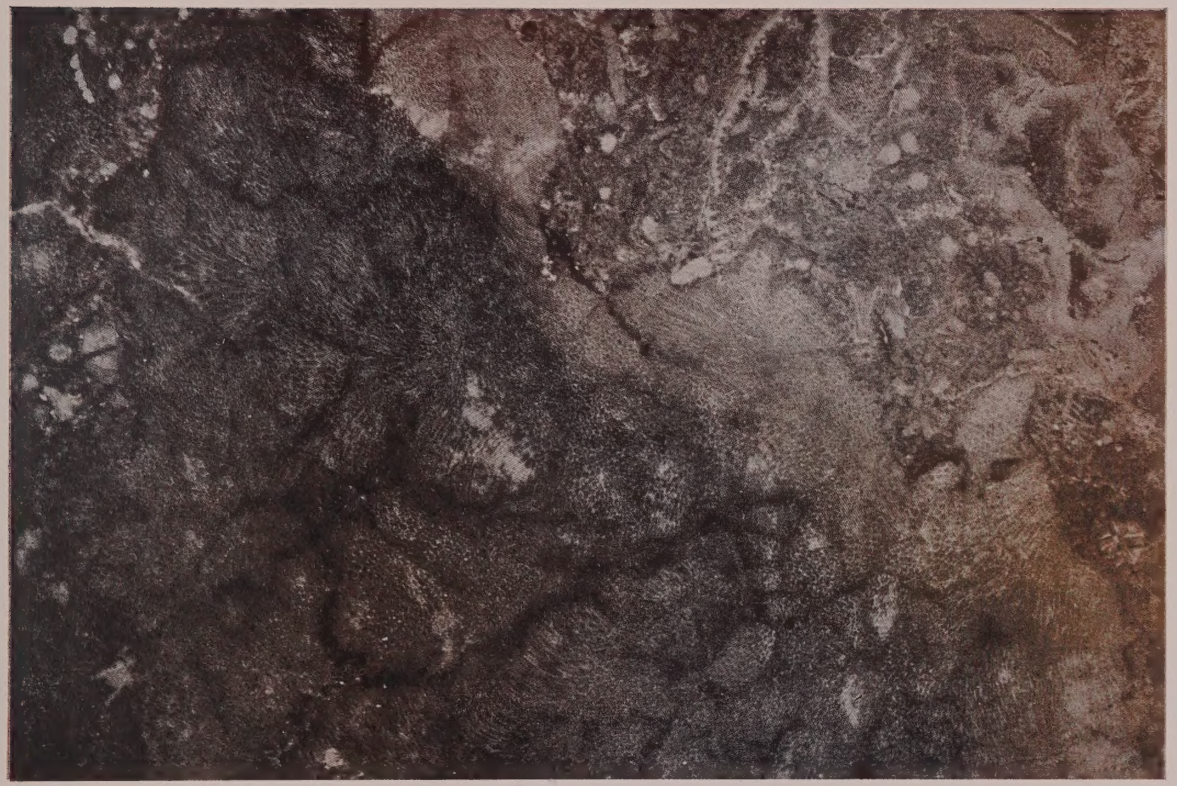
BORENORE MARBLE (BLUE), N.S.W.

Nat. Size.

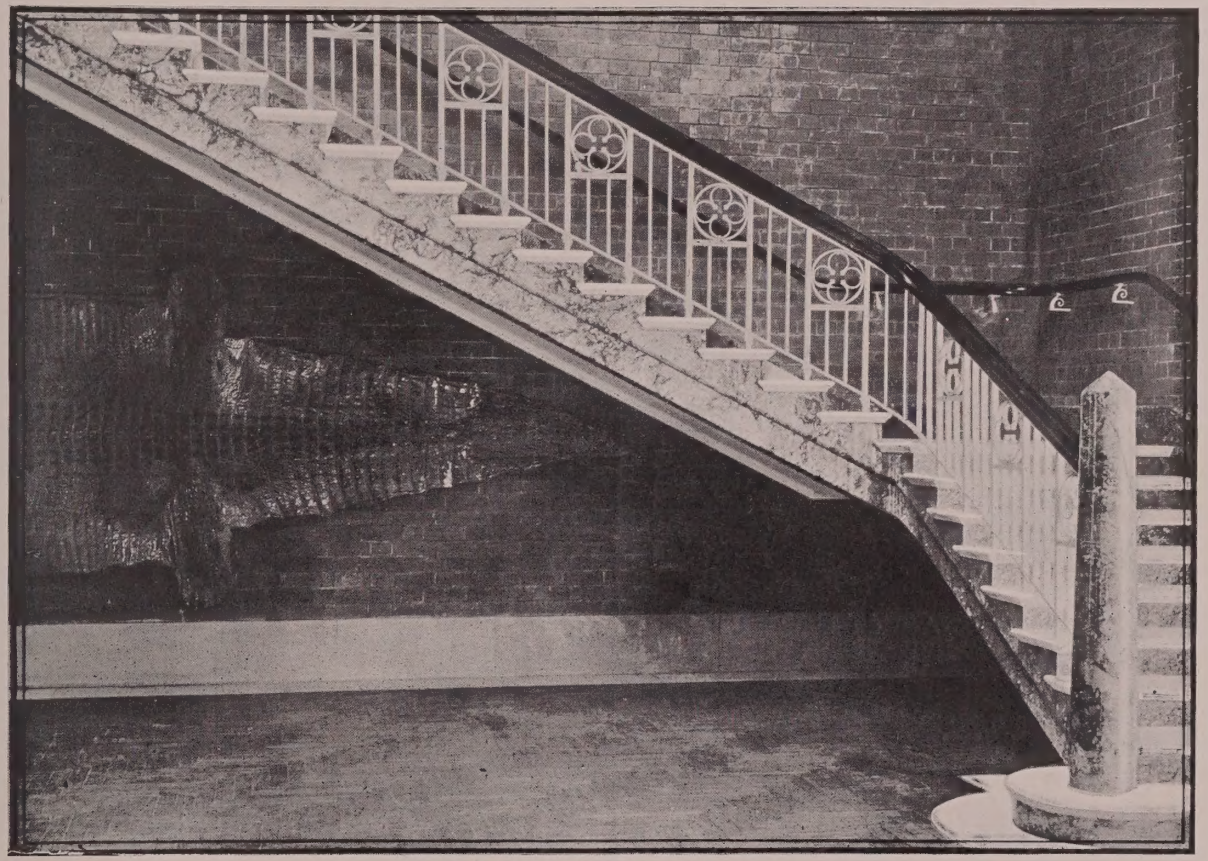


BORENORE MARBLE (RED), N.S.W.

Nat. Size.



BUCHAN MARBLE, VIC. *Nat. Size.*



BORENORE MARBLE.

(STAIRCASE WEST MAITLAND TECHNICAL COLLEGE N.S.W.)

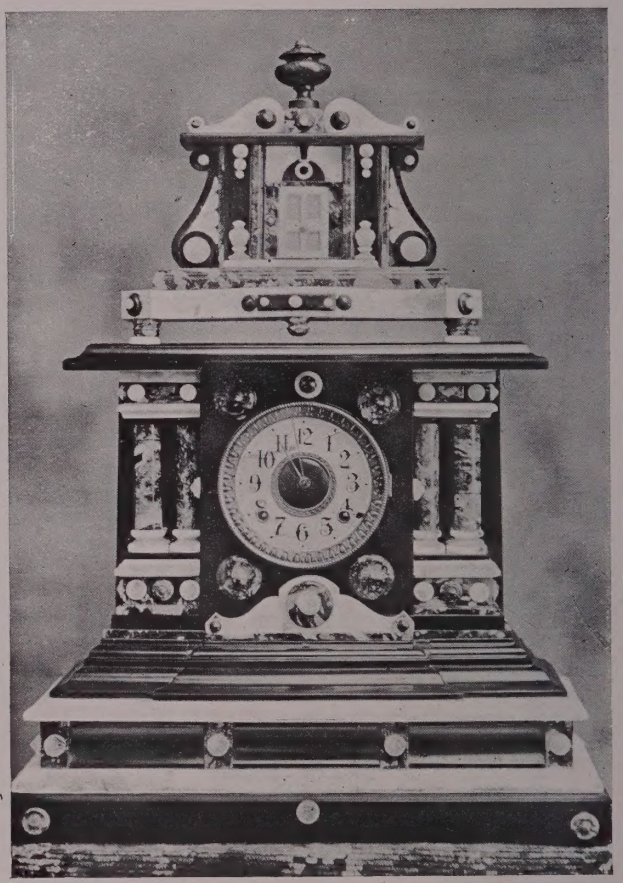
Bingera, N.S.W.—*contd.*

intervals between Warialda, Bingera, Barraba, Manilla, and Tamworth; whilst Attunga is also upon this line of outcrop.

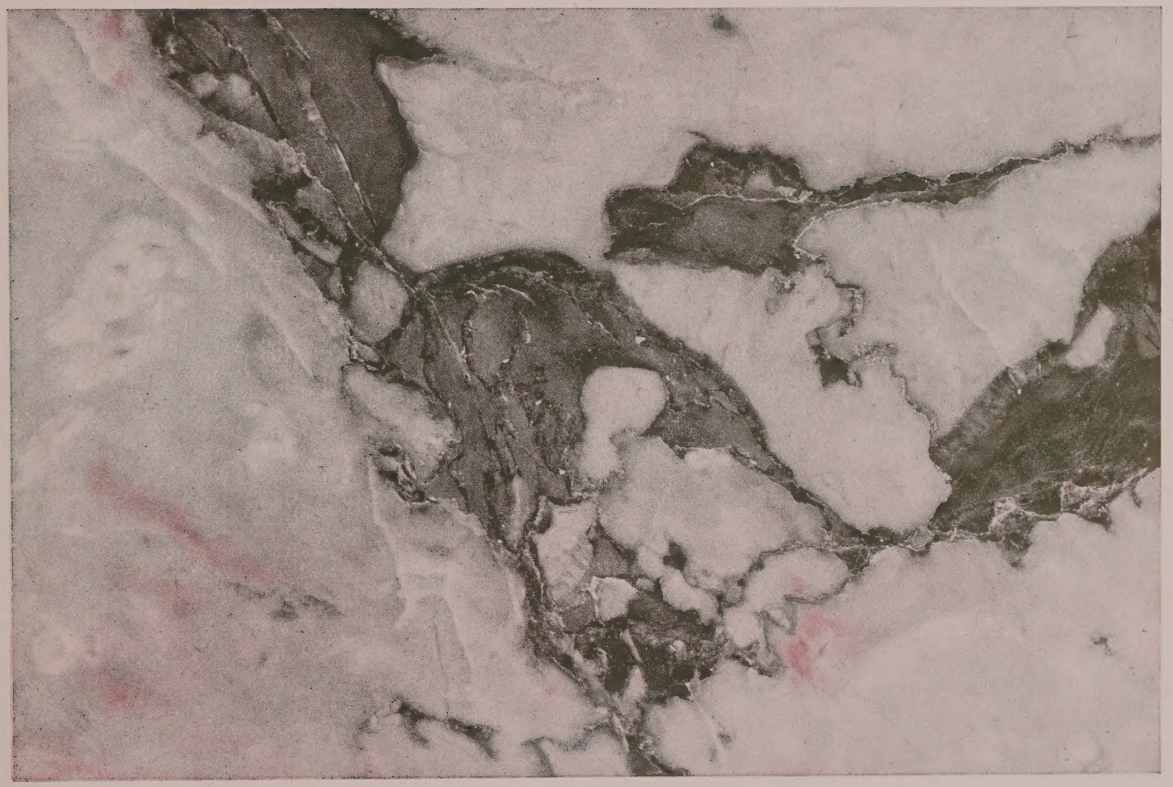
BORENORE, N.S.W.—Many varieties are produced from this quarry, which is within easy distance of the railway. The deposit is extensive and so is capable of yielding large quantities of stone. The two varieties at present being utilised are a red and a blue. The former, which is a breccia of red and buff coloration, is gaining great favour in Sydney, and has been employed for mural decoration in the New Central Railway Station and many other Sydney buildings; it makes up well for mantelpieces, church columns, &c., and is, therefore, a first-class decorative stone. The blue is a breccia, with this colour predominating, and the fossil corals being well brought out in the polishing, give a very rich effect to this stone. It is one of the most beautiful marbles yet discovered in New South Wales. For mantelpieces it is particularly effective, but would be equally so in other directions of ornamentation.

BRUNDLE CREEK, N.S.W.—A white marble obtrudes here, almost identical with that of the Tarrabandra stone.

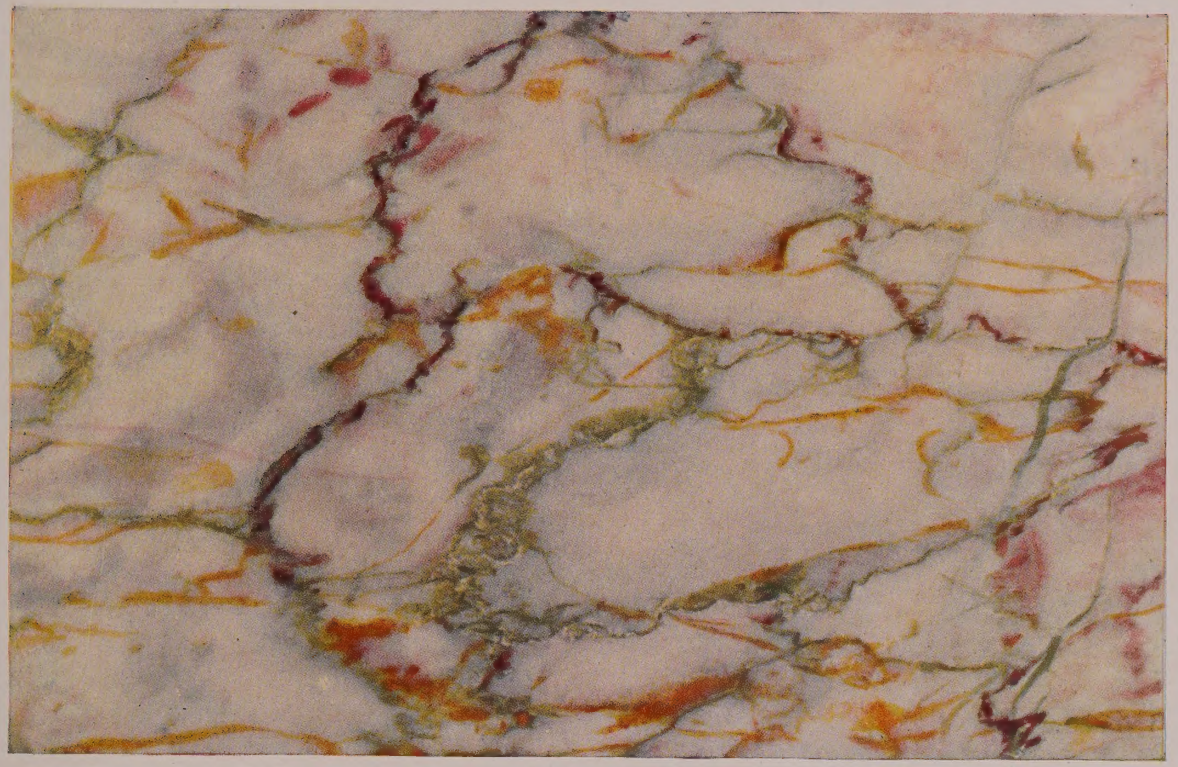
BUCHAN, Vic.—This is a marble that is now coming gradually into use in Melbourne. It may be described as having two colours, a black and a drab or grey. The black is deep with small crinoids scattered through it, but is not nearly so highly figured as the New South Wales Rockley or Victorian Toongabbie Marbles.



MADE OF NEW SOUTH WALES MARBLES BY F. RUSCONI.



DARK GREEN CALEULA MARBLE, N.S.W.

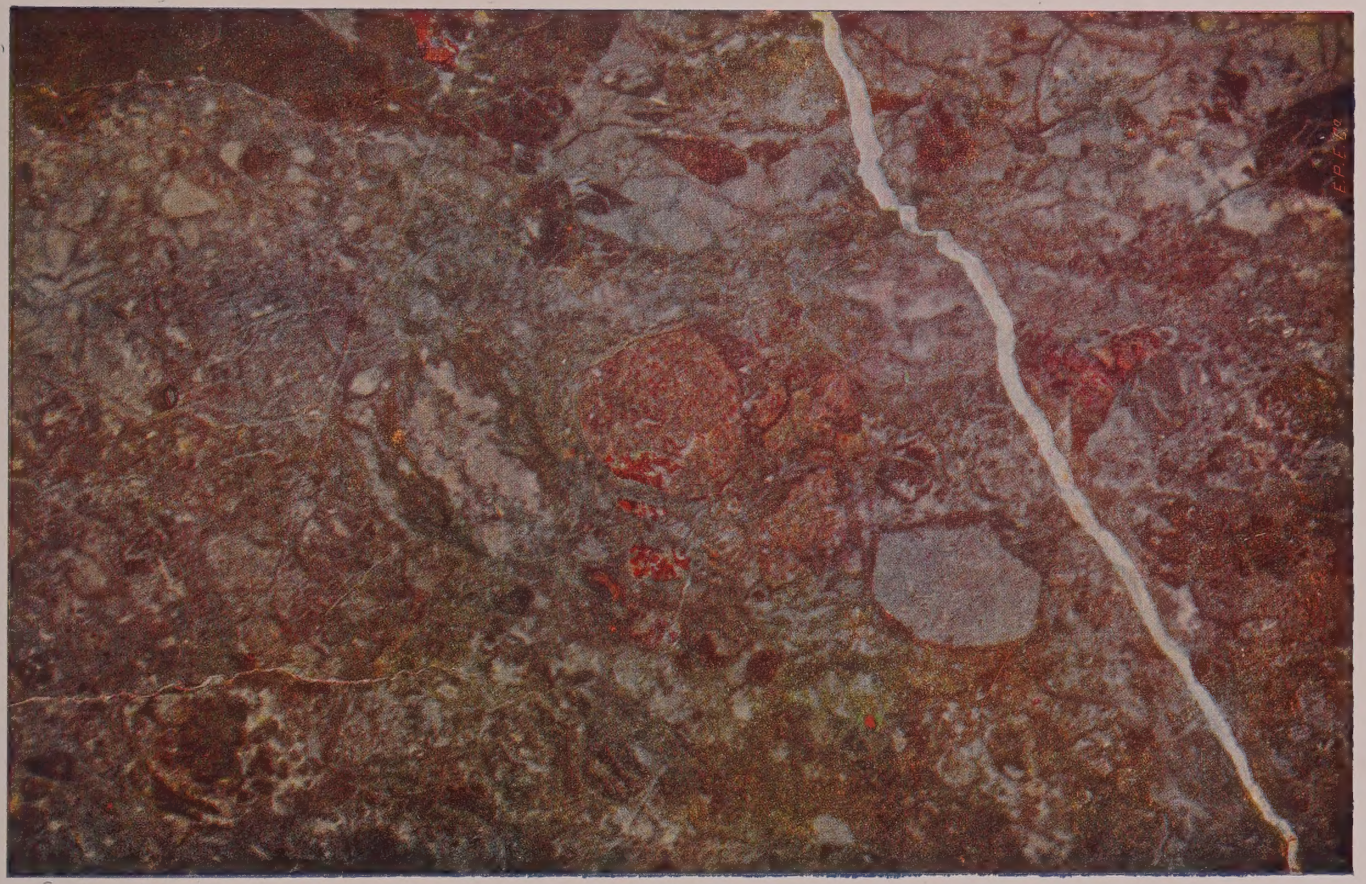


GREEN CALEULA MARBLE, N.S.W.

Nat. Size.

FERNBROOK MARBLE (THE QUEEN ALEXANDRA)

N.S.W.

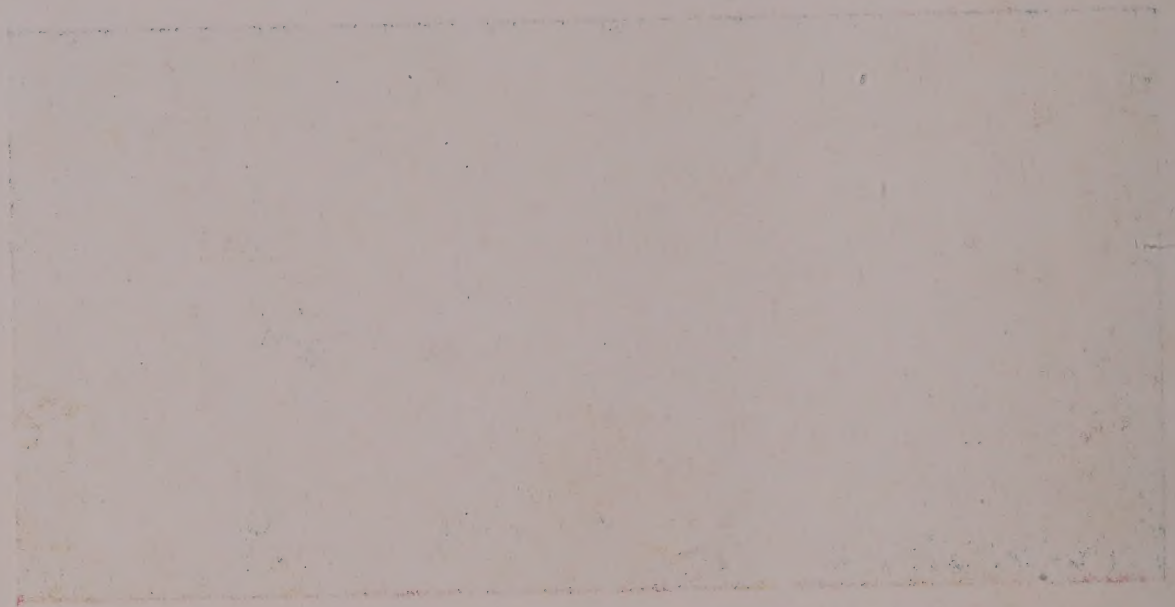


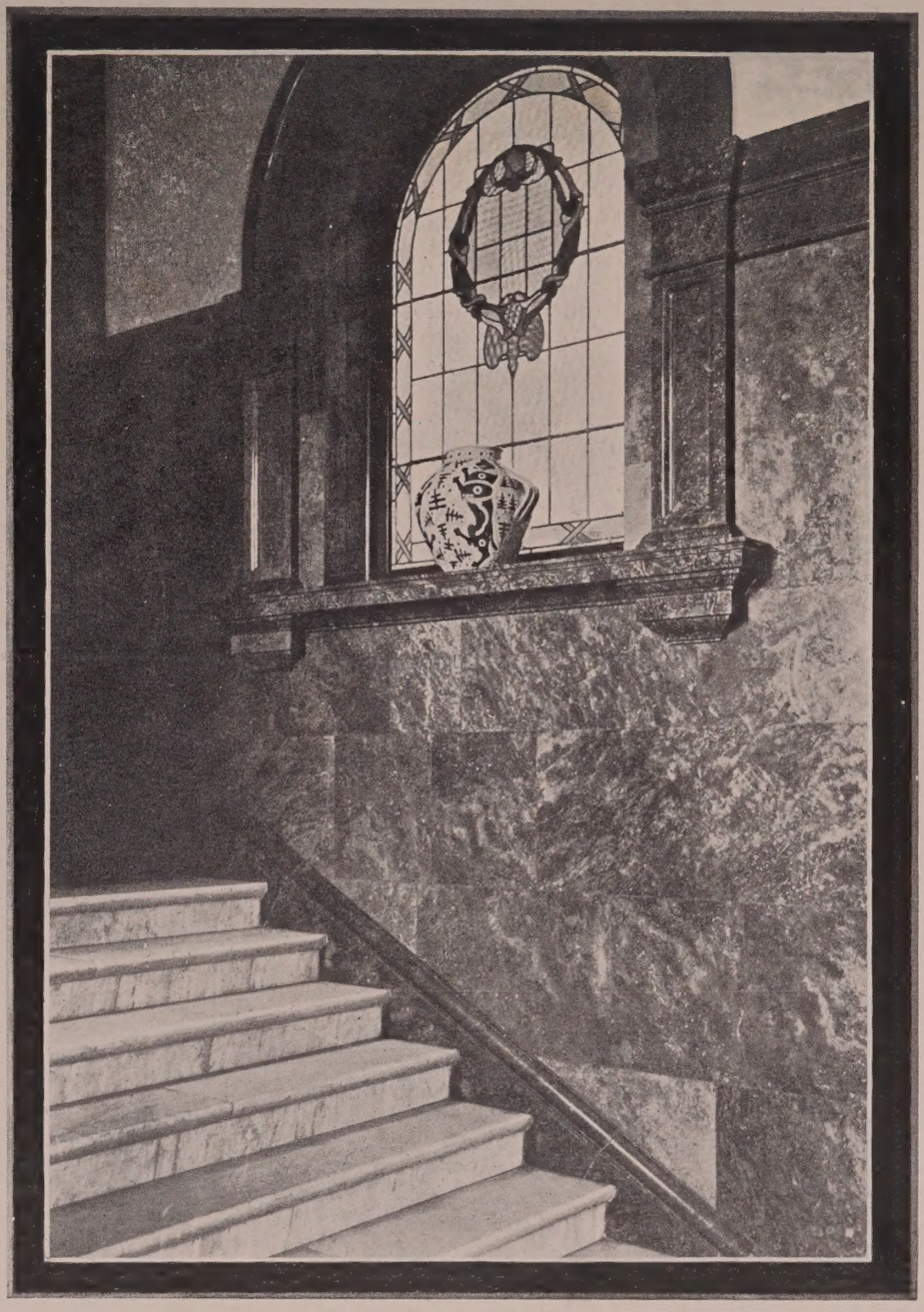
FERNBROOK MARBLE, N.S.W.

Nat. Size.

FERNBROOK MARBLE, N.S.W.

Half Nat. Size.





BUCHAN MARBLE (VICTORIA.)
(PUBLIC LIBRARY, MELBOURNE.)

Buchan, Vic.—*contd.*

The grey has been used as panels along with the black in the Public Library and other interiors in Melbourne buildings, but the earthy colour of the latter variety does not appeal to everyone.

A good white streaked marble also occurs at Buchan.

BUCKEROO, N.S.W.—Many coloured marbles can be obtained from this locality. They range from yellowish-brown to yellowish-grey or red in colour, and the indications from surface specimens are that a good white might be found when opened up.

BUMBALDRY, N.S.W.—A very extensive area of marble outcrops near the main road, about 1 mile west of the township. The rock is of a richly-variegated red colour, with some varieties merging into a deep brick red. As there are unlimited quantities available, this should be a useful addition to our list of first-class marbles.

BUNGENDORE, N.S.W.—A limestone of a dark grey colour is found about 6 to 8 miles east of this township.

BUNGONIA, N.S.W.—A buff-coloured marble.

BURROWA, N.S.W.—A rather handsome marble with large red markings occurs near Burrowa. (*F. Rusconi.*)

CALEULA, N.S.W.—This marble occurs some distance (16 miles) from Orange. The deposit is large, and so is capable of extensive development.

Caleula, N.S.W.—*contd.*

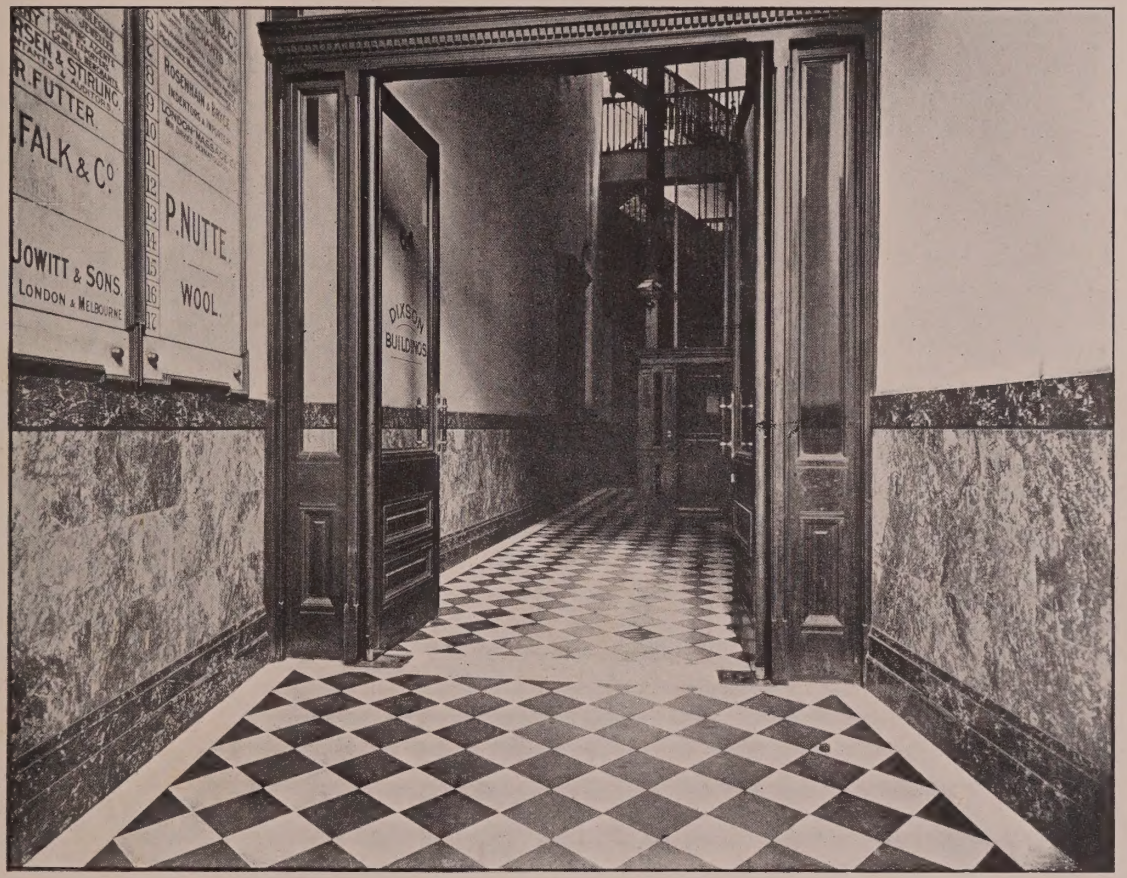
The predominant variety is a beautiful white and red streaked stone, approaching somewhat in colour some of the Borenore specimens. It is a very attractive stone, and has been used exclusively in the interior decoration of St. James' Church and Dixson Buildings, Sydney.

There is also a very prettily-marked mottled variety with green streaks that will come into demand when better known.

CALLIOPE, Q.—A bed of marble, probably the equivalent of some of the limestone beds at Langmorn and Raglan, crosses the Calliope River, about a mile below Carrara Station, 12 miles S.W. of Gladstone. It has been quarried and shipped in small schooners, which, at high tide, can come up the river as far as this bar. This marble would be valuable for statuary purposes. (*R. L. Jack, F.G.S.*)

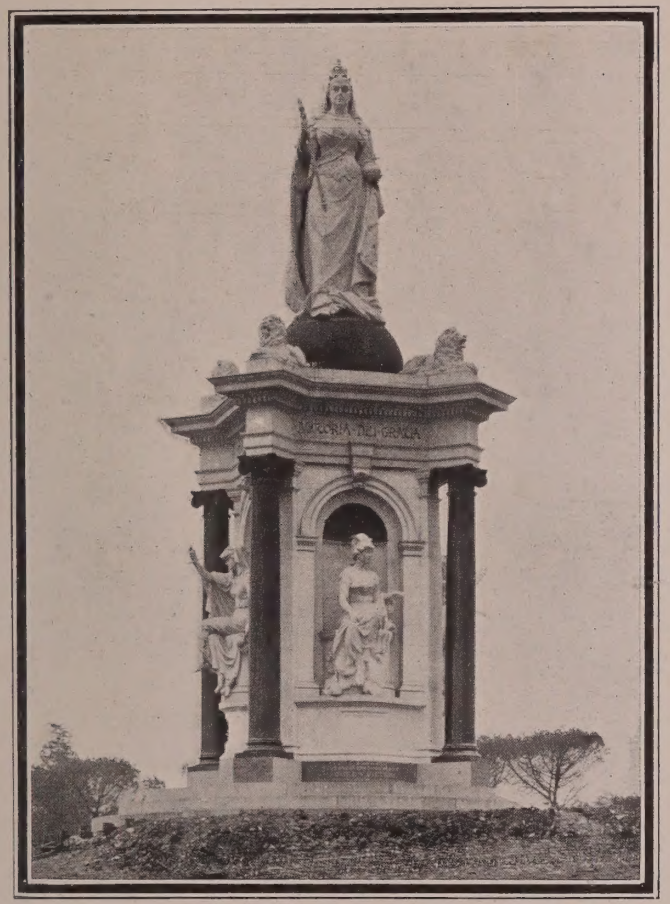
Marble also occurs at Ferguson's Crossing, near Catfish, 21 miles S.W. of Gladstone.

CALOOLA, N.S.W.—This newly-opened and latest machinery-worked quarry is situated between the Newbridge and Bathurst railway stations. It is a whitish, coarse-grained marble, occasionally decorated with very faint bluish clouds, but pure white-coloured material will no doubt be encountered as the depth worked is increased. It is a very fine marble, and is quickly coming into favour in the Commonwealth, for it is now to be seen in some form or other in the newest architectural structures of Sydney, such as the vestibule of Challis House,



CALEULA MARBLE DADO.
(DIXSON BUILDINGS, SYDNEY.)

ONE OF THE CUTTINGS AT THE CALOOLA WHITE MARBLE QUARRY.



CALOOLA MARBLE.
(QUEEN VICTORIA STATUE, MELBOURNE.)

Caloola, N.S.W.—*contd*

Martin Place, and Prince Alfred Hospital, also Queen Victoria Statue, Melbourne, &c. Its utilisation qualities are too numerous to mention here, but for indoor work of all kinds it is an excellent marble. The plates illustrating this marble were kindly lent by the Commonwealth Marble Co.

CARROLL, N.S.W.—Variegated marbles occur near here. (*D. A. Porter.*)

CHILLAGOE, Q.—White, fine quality, near Chillagoe.

COOLALIE, N.S.W.—A deposit of marble occurs in this locality, about 1 mile north of the station, in a level, accessible situation. It outcrops in the form of large boulders over several acres of country, and at a short distance below the surface merges into solid rock. Like most marble deposits, the texture shows several varieties. The surface specimens have a yellow stain, but this would most probably disappear as the solid material is reached, which from indications should be snow white.

The samples examined may be classed in colour as white, reddish tinge, and brown.

COOMA, N.S.W.—White marble is found at Tollbar, 5 miles N.E. of Cooma.

COW FLAT, N.S.W.—Here is found a whitish marble, but not yet much worked.

COWRA, N.S.W.—Dark-coloured limestone occurs as a bold outcrop, striking north and south, and cutting across the Burrowa Road about 8 miles from Cowra.

CALOOLA MARBLE FLOOR.

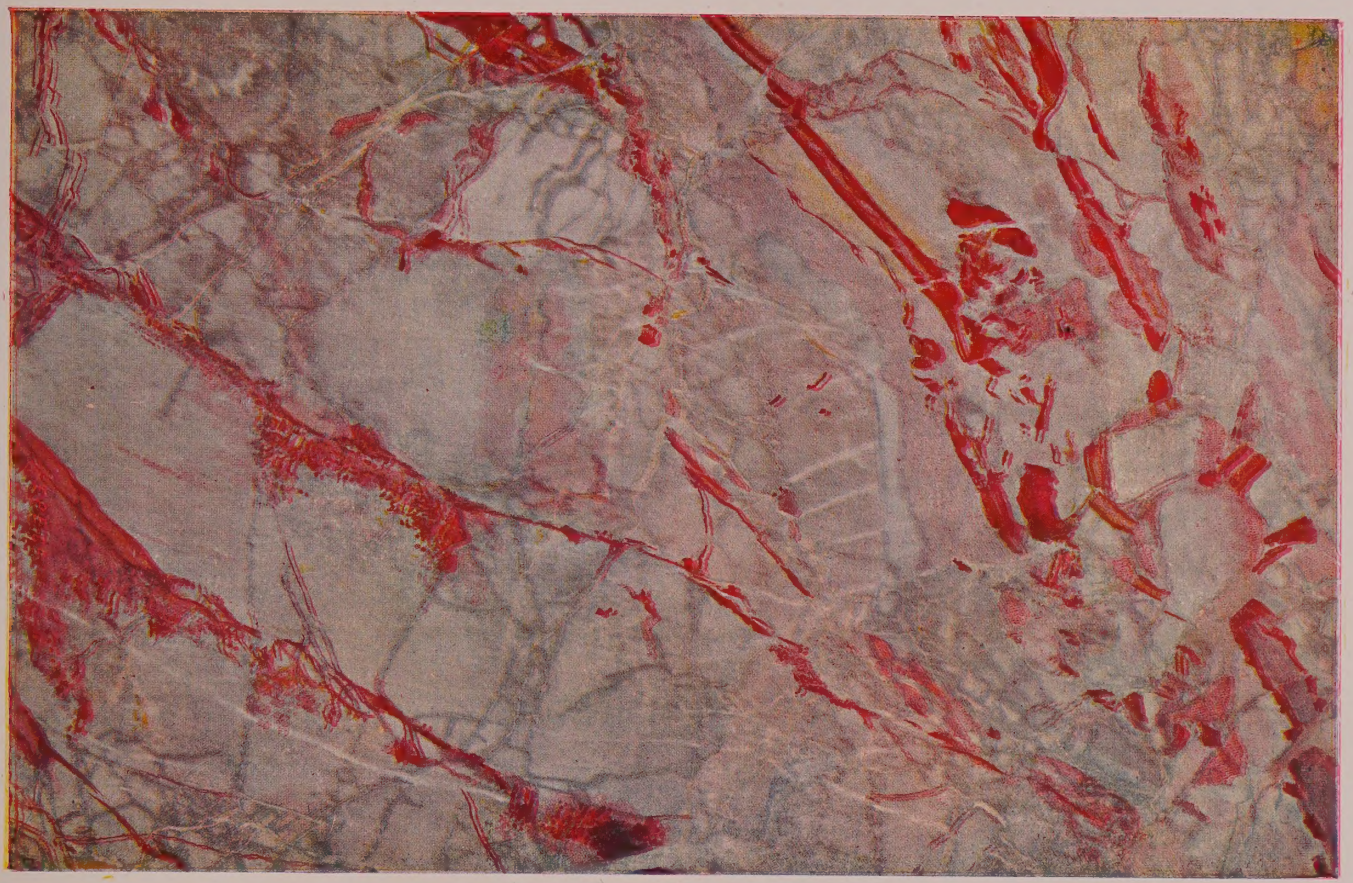
(VESTIBULE, ROYAL PRINCE ALFRED HOSPITAL SYDNEY.)

Half Nat. Size.

FERNBROOK MARBLE, N.S.W.

FERNBROOK MARBLE, N.S.W.

Half Nat. Size.



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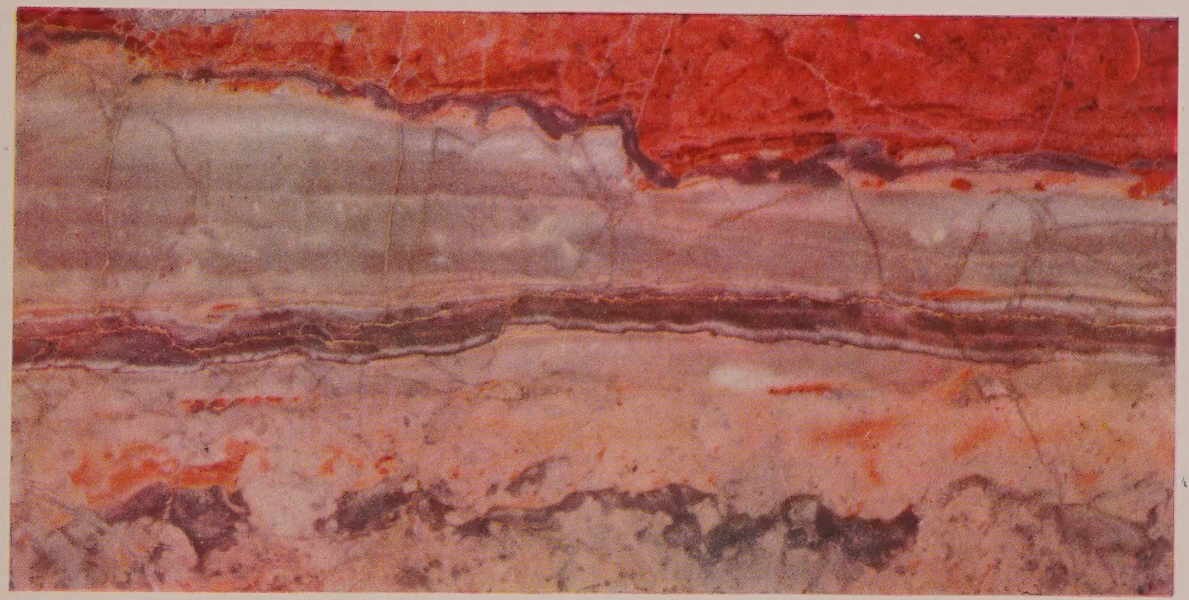
FERNBROOK MARBLE.

N.S.W.



Half Nat. Size.

FERNBROOK MARBLE

N.S.W.

FERNBROOK MARBLE STAIRS. CALOOLA PAVEMENT.

(VESTIBULE, HER MAJESTY'S THEATRE, SYDNEY.)

CUDAL, N.S.W.—This is a bluish-black stone, but not much known.

FERNBROOK, N.S.W.—The varieties produced from this district are too numerous to particularise here, as they range in colour through almost the whole spectroscope.

There are great commercial possibilities for these beautifully coloured and wonderfully figured marbles, and many of them will no doubt be found superior to the European and American article. The coloured plates lent by the Commonwealth Marble Co., and shown here, will give some idea of the varieties obtainable.

GALENA POINT (near Geelong), Vic.—A stratified limestone, coloured or striped along the building plane. It has a handsome appearance when polished. (*Chapman.*)

GEORGES PLAIN, N.S.W. (near Bathurst).—From this district, in the same general line of country as the Caloola and Cow Flat deposits, comes a white marble of hard crystalline texture, which in appearance is very similar to the famed Penteilkon marble. It occurs in sufficient quantity to obtain large blocks free from faults. It is eminently suited for the monumental, building, and kindred trades. (*M. Ferranti.*)

GIGOOMGAN HEAD, Q.—Station, 35 miles W.S.W. of Maryborough.

GILMORE, N.S.W.—Here occurs what is probably the finest white or statuary marble yet unearthed in N.S.W.

It outcrops at the side of the mountain at Upper Gilmore, 15 miles S.W. of Tumut. The belt strikes N.W. and S.E., and is approximately about 120 feet in thickness, with an almost vertical stratification giving it a well defined grain. It thus splits readily into slabs, sometimes very thin, although some large pure-white blocks have been obtained, the prevailing colour being pink, banded with dark green laminæ. It is fine-grained, even in texture, pure white, having a translucency near the edges, or in thin slices. At greater depths larger blocks would be most probably found. The quarry is worked by Mr. Back, of Gilmore, for lime.

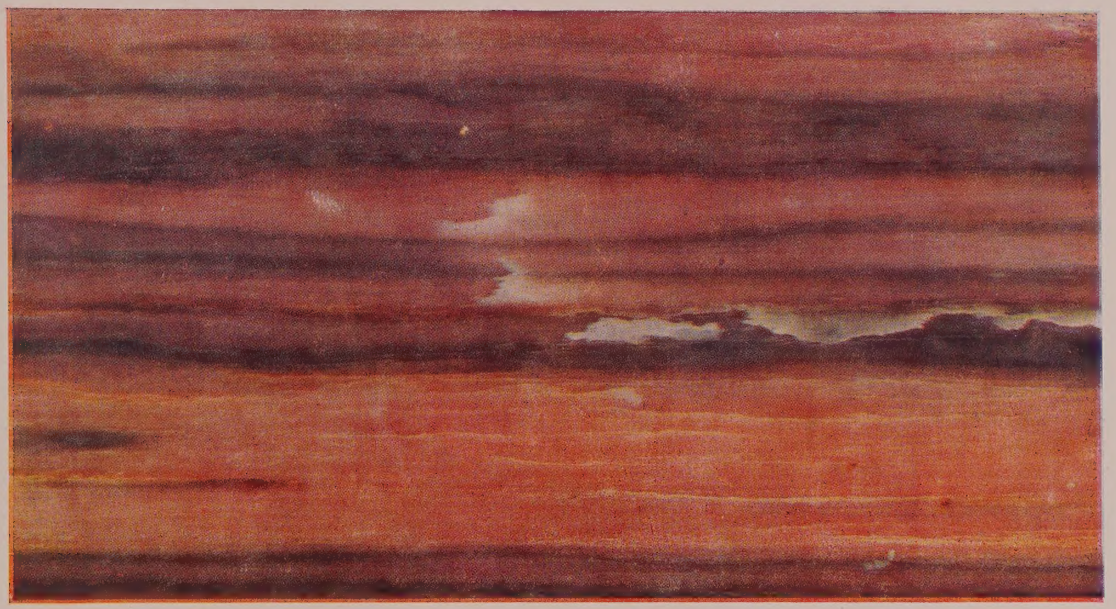
GOULBURN, N.S.W.—At Shea's Creek, 6 miles east of the town, a red marble outcrops.

GRESFORD, N.S.W.—Gresford, near Maitland (Mr. Thos. Browne). A dark-coloured crinoidal marble which takes a fair polish. Used for lime-burning.

GUNDAGAI, N.S.W.—This marble is not much known, and is unworked.

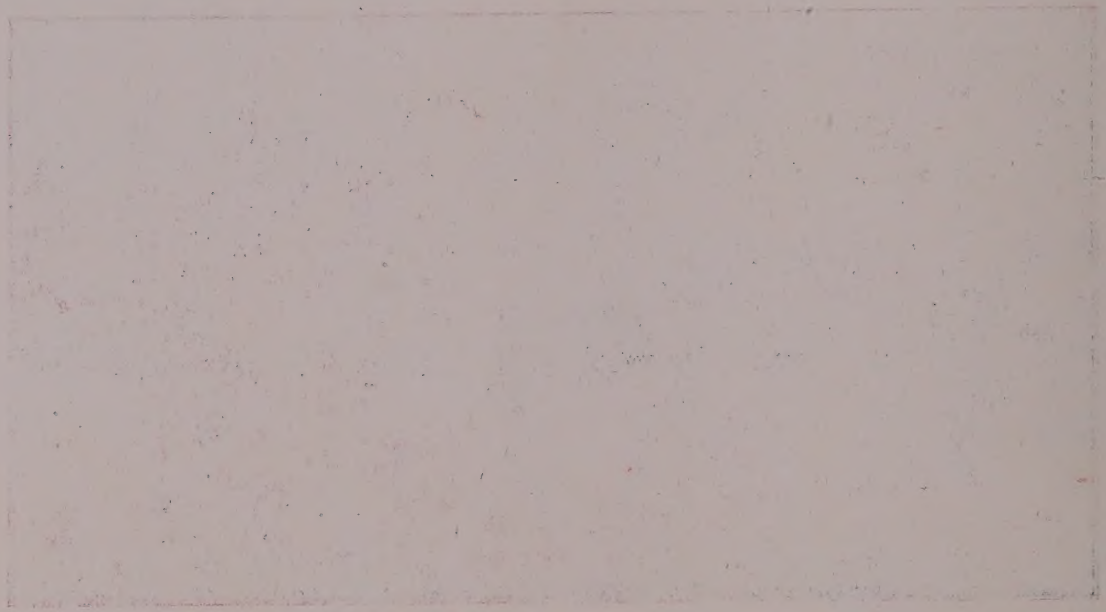
HAVILAH, N.S.W.—According to Mr. C. F. Summers, this is a variety of white marble, and one that gives promise of yielding one of the finest white varieties yet found in the State. This authority also states the supply is unlimited.

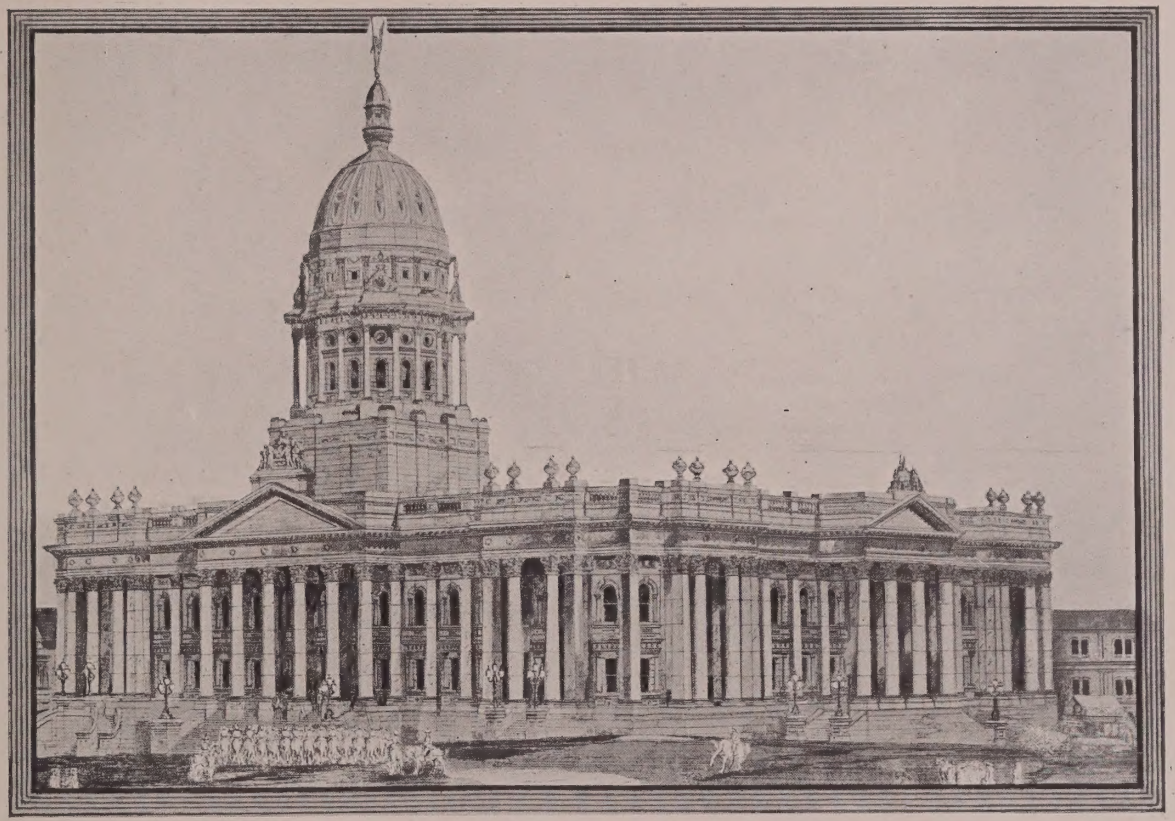
HERBERTON, Q.—12 miles S.S.W. of Atherton railway station.



GILMORE BANDED MARBLE, N.S.W

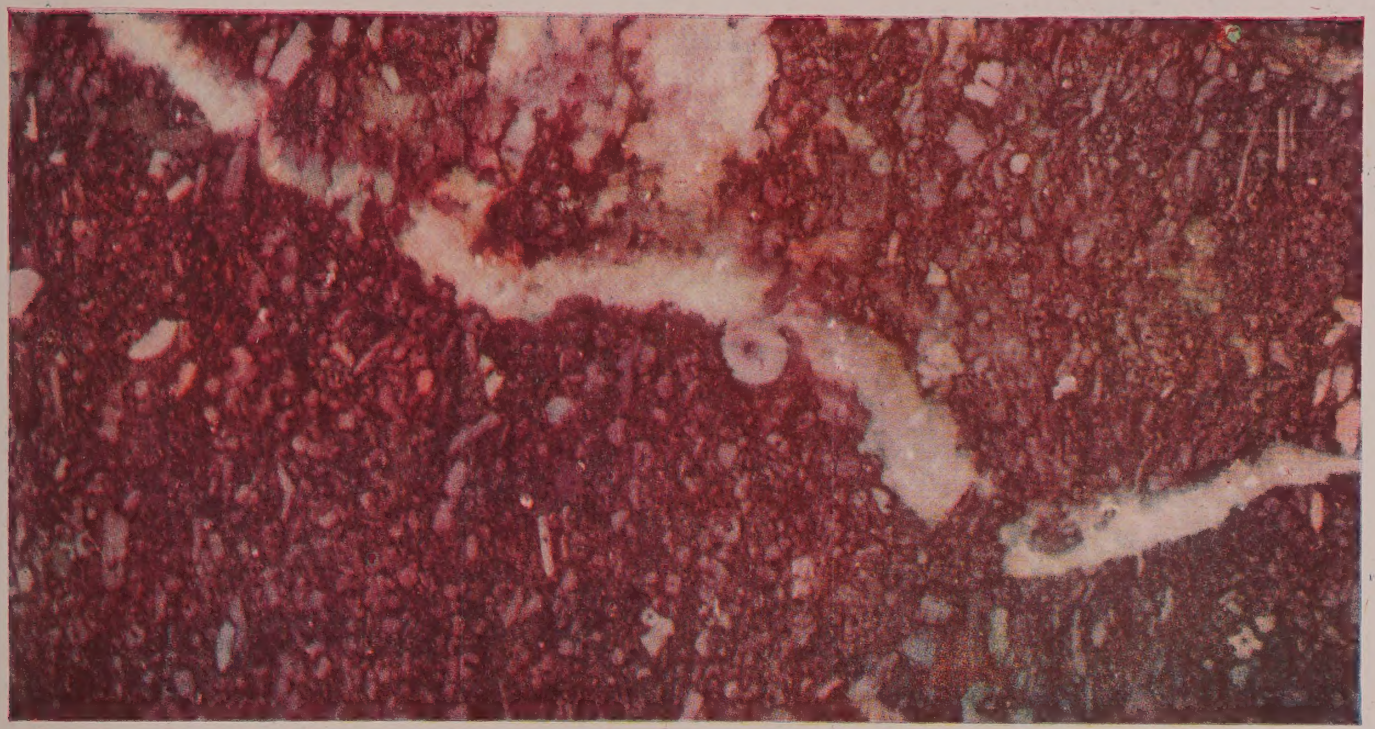
Nat. Size.





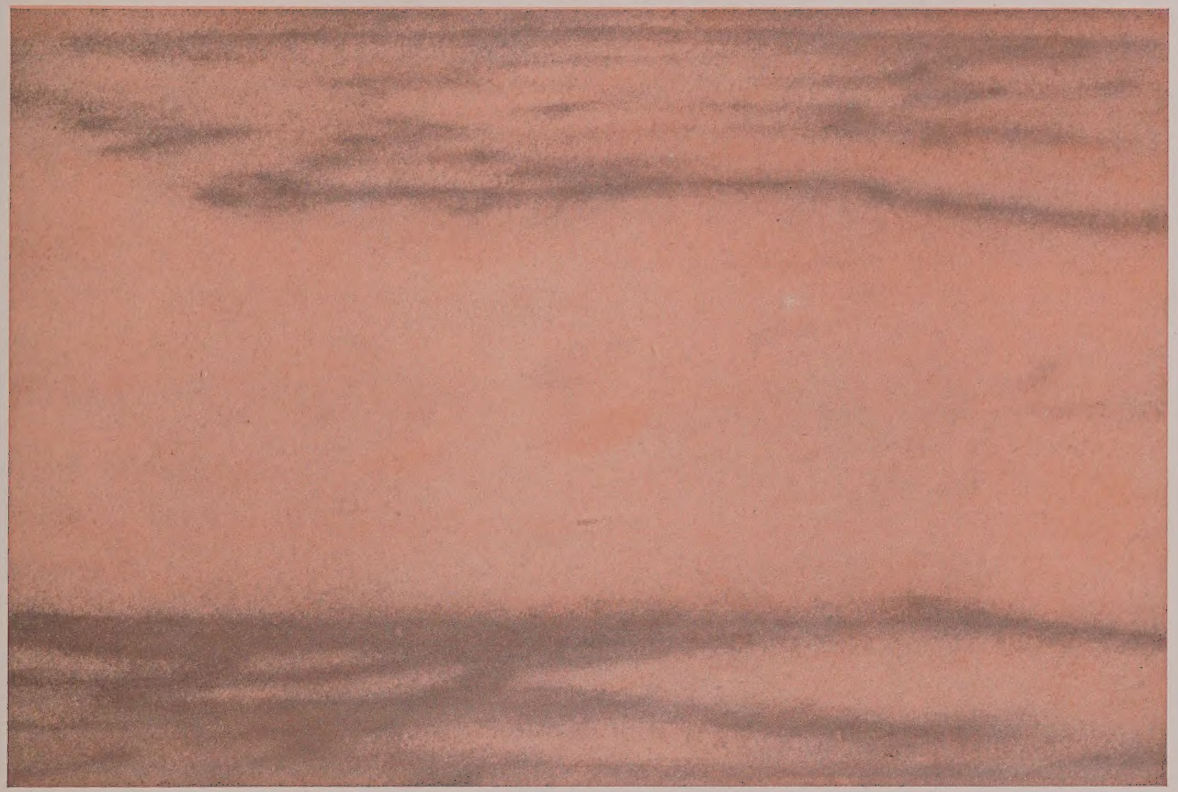
BASE COURSES AND STEPS, WEST ISLAND GRANITE.
UPPER STRUCTURE, KAPUNDA GREY MARBLE.
(PARLIAMENT HOUSE, ADELAIDE, S.A.)

DOME OF SYDNEY SANDSTONE. COLUMNS OF KEMPSEY MARBLE.
(THE VESTIBULE, NATIONAL ART GALLERY, SYDNEY.)



KEMPSEY MARBLE, N.S.W.

Nat. Size.



MACCLESFIELD MARBLE, S.A.

HUNTER ISLAND, Q.—Duke Group, 45 miles N.E. by E. of St. Lawrence.

The marble is minutely crystalline, white, and quite fit for ornamental architecture or statuary. A pink marble is a very beautiful stone suffused with a faint blush rose tint. (*R. L. Jack.*)

IRON ISLAND, Q.—Duke Group. White saccharoidal.

JEIR, N.S.W.—One mile south of Jeir on the main road an outcrop of marble occurs. It is unworked. The colour varies from a light to a deep chocolate, and often shows a pretty mottling.

JENOLAN, N.S.W.—An unworked marble.

KANGAROO HILLS, *Q.*—Mineral Field, 40 miles S.W. by S. of Ingham. White saccharoidal.

KAPUNDA, S.A.—This district is one of the main sources of supply of marble for South Australia, and several varieties are worked, the principal being :—

(*a*) This is a fine grey marble, with dark and lighter patches toning down in places to very pale coloured or almost white.

(*b*) A pale fawn-coloured material with dark cloudy patches.

(*c*) A light coloured greyish ground with perhaps a faint inclination to blue, while running through are uneven bands or streaks of black. A pretty marble, and one of the best in South Australia.

KEMPSEY, N.S.W.—A very ornamental and quite uncommon marble. The matrix, which has a warm, chocolate colour, is studded with small white crinoids, and through the whole run veins of white limestone. When polished it presents a very attractive and beautiful figure, and shows to special advantage in column form. The large columns of the National Art Gallery, Sydney, are made of this material, and are much admired.

LIMEKILNS, N.S.W.—Some very prettily-marked specimens can be obtained from this extensive marble locality, which, from want of demand, is not now being worked.

LIMESTONE CREEK, Vic.—Several varieties occur here, *i.e.* (*a*) Red and pink markings with a white ground. (*b*) Pale grey; and (*c*) Slate coloured.

A great variety of marbles appears to be procurable in this neighbourhood, of many shades and figures. One is a very large brecciated sample not unlike that found at Attunga, N.S.W. It would look well in large columns, hall decorations, &c.

MACCLESFIELD, S.A.—The marbles from this district are of several colours, and the five principal ones in use are—

(1) *Cream.*—This has a cream ground with dark markings, and is certainly worthy of far more utilisation than is at present given to it.

(2) *Grey.*—A grey, figured with darker clouds, and is a good stone for decorative purposes.

(3) *Dark Grey.*—This marble differs from No. 2 in being of a darker shade, with a pale grey cloudiness and black patches.

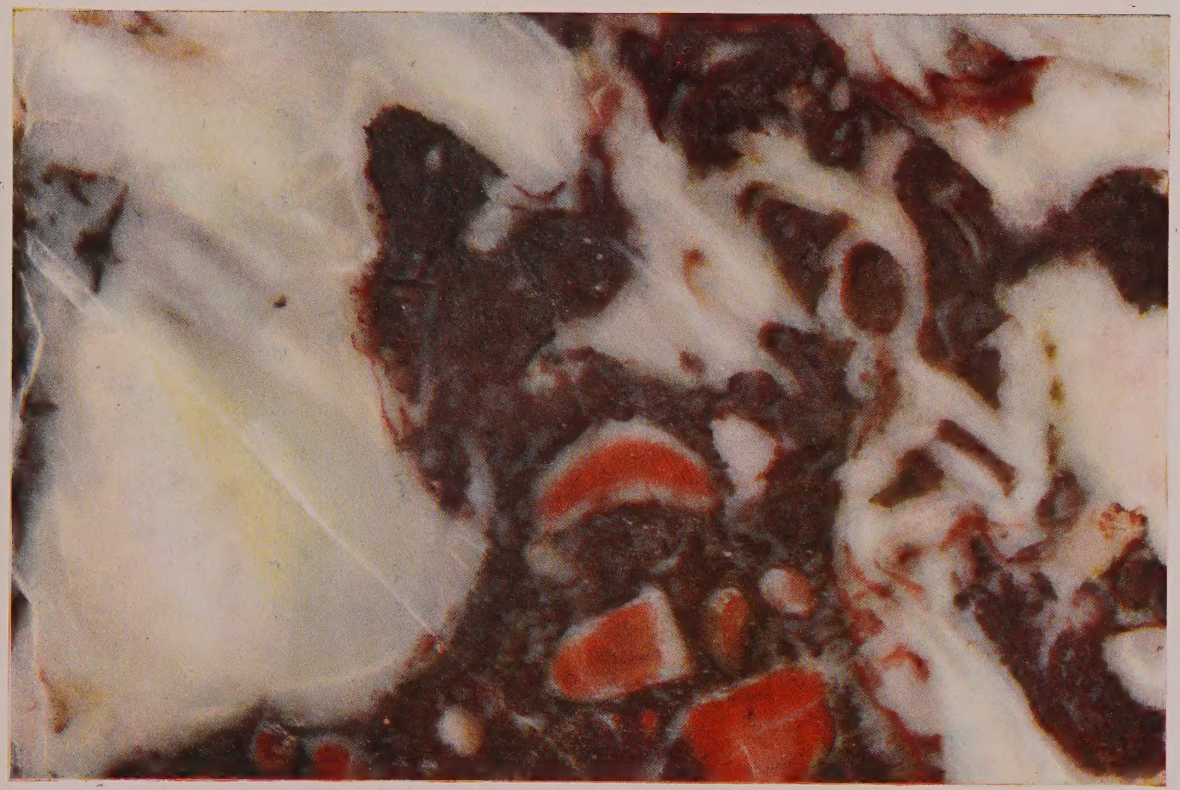
MARULAN MARBLE, 1835.

CAMDEN HOUSE, N.S.W.

GAMBOOLA MARBLE (MOLONG).

N.S.W.

Half Nat. Size.



MARULAN MARBLE N.S.W.

MICHELAGO MARBLE, N.S.W.

MOLONG MARBLE, N.S.W.

Macclesfield, S.A.—*contd.*

(4) *Pink.*—A pleasing pale pink-coloured stone, with grey patches or streaks running through it, and an even fine-grained texture. It looks well unpolished, as well as polished.

(5) *Red.*—A darker shaded stone than No. 2, with more of a salmon pink colour characterising it. All these are used in monumental work, and are in demand.

MANSFIELD, Vic.—This is a crinoidal marble with white streaks and dark markings.

MARBLESTONE, Q.—Raggott Creek, a tributary of Fuller's Creek, Boyne River, 20 miles S. of Gladstone. Grey and white. Very beautiful brecciated marble occurs in this locality, which is well adapted for ornamental work. The colour of the stone is grey, white, and red.

MARTIN CREEK, Vic.—This may be classed as a black marble, but not so distinctly black as Windellama, New South Wales.

MARULAN, N.S.W.—This deposit is close to the Wollondilly River, about 7 miles from Marulan, and is now of interest chiefly from its historical associations. Marble was worked here as early as 1830, and it was the first quarry opened in Australia. A considerable range of colour is to be found, but the most noteworthy variety is one which approaches very closely in texture and translucency the famous Mexican "onyx." This was used in mantelpieces in the early days of the colony.

MICHELAGO, N.S.W.—A very large deposit of marble outcrops on the Murrumbidgee River, 2 miles west from the township. There are many varieties, which include white, yellow, brown, blue, and pink coloured marbles. A purple or wine-coloured, crinoidal variety is very handsome, and similar in appearance to the Kempsey stone.

In addition to this, several other distinctive marbles come from the same locality, including a handsome variety with a pale pink ground in which are scattered small patches of purplish red, and another with a wavy figure produced by bands of light chocolate or fawn colour, alternating with white.

MOLONG, N.S.W.—This is one of the most extensive areas of marble in the State, but samples are not placed at present on the Sydney market, although largely used locally for the many purposes for which this stone can be utilised.

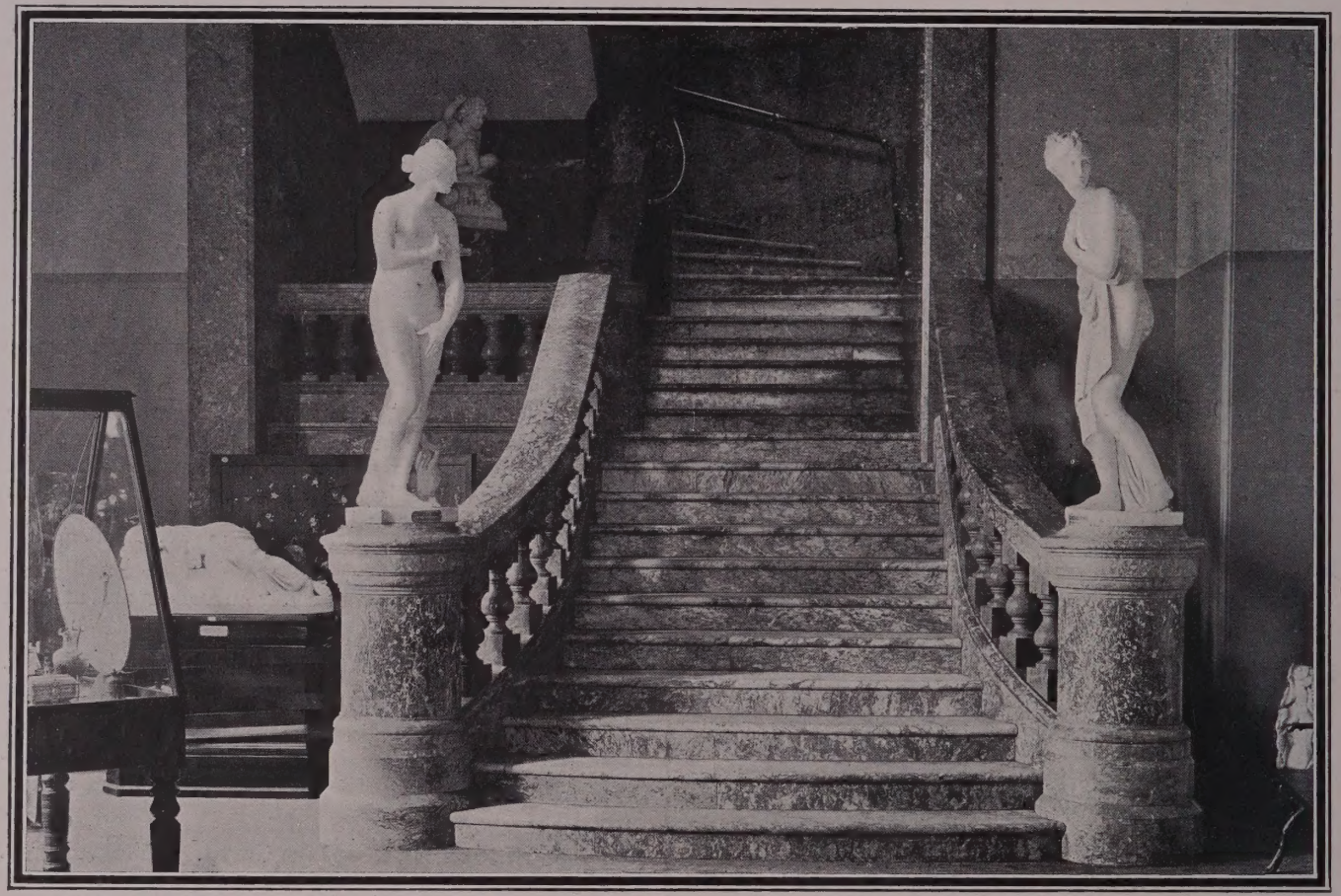
A great future awaits this field, for, according to Mr. C. F. Summers, the varieties obtainable are equal to anything produced from ancient and modern European quarries.

MOONBI, N.S.W.—An extensive field, but undeveloped.

MOORABOOL, Vic.—This is a good hard limestone with a distinct yellowish tinge, and has been used in the construction of the Police Courts, Russell-street, Melbourne, the Malvern Post Office, and in the Bendigo R.C. Cathedral.

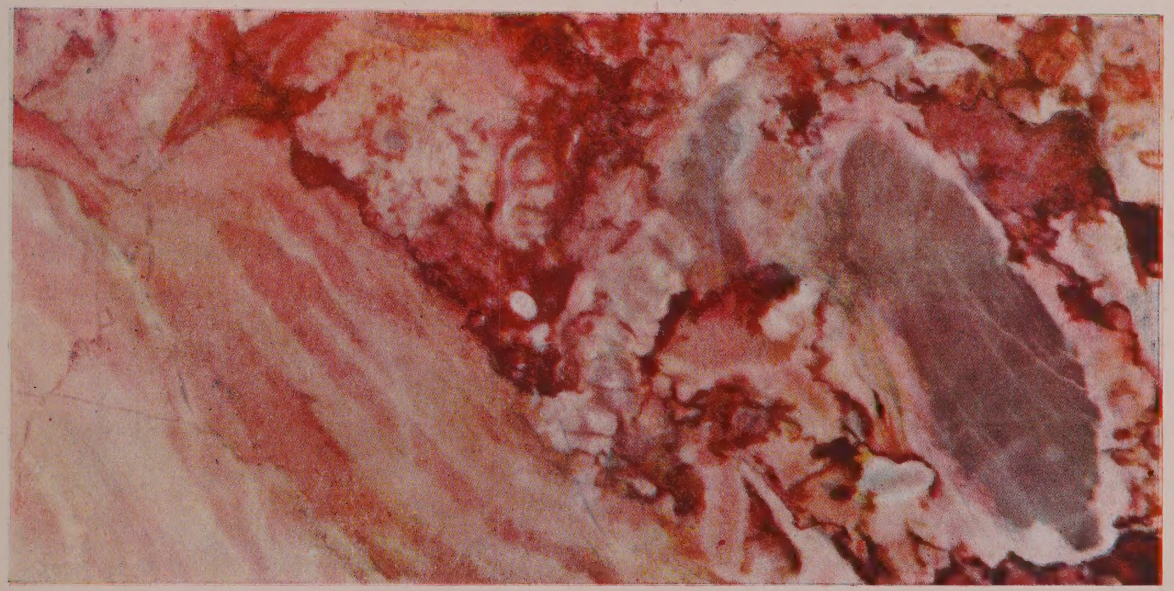
MORETON ISLAND, Q.—Duke Group. White and grey.

MT. EMMA, Q.—Three miles N.E. of Palmerville.



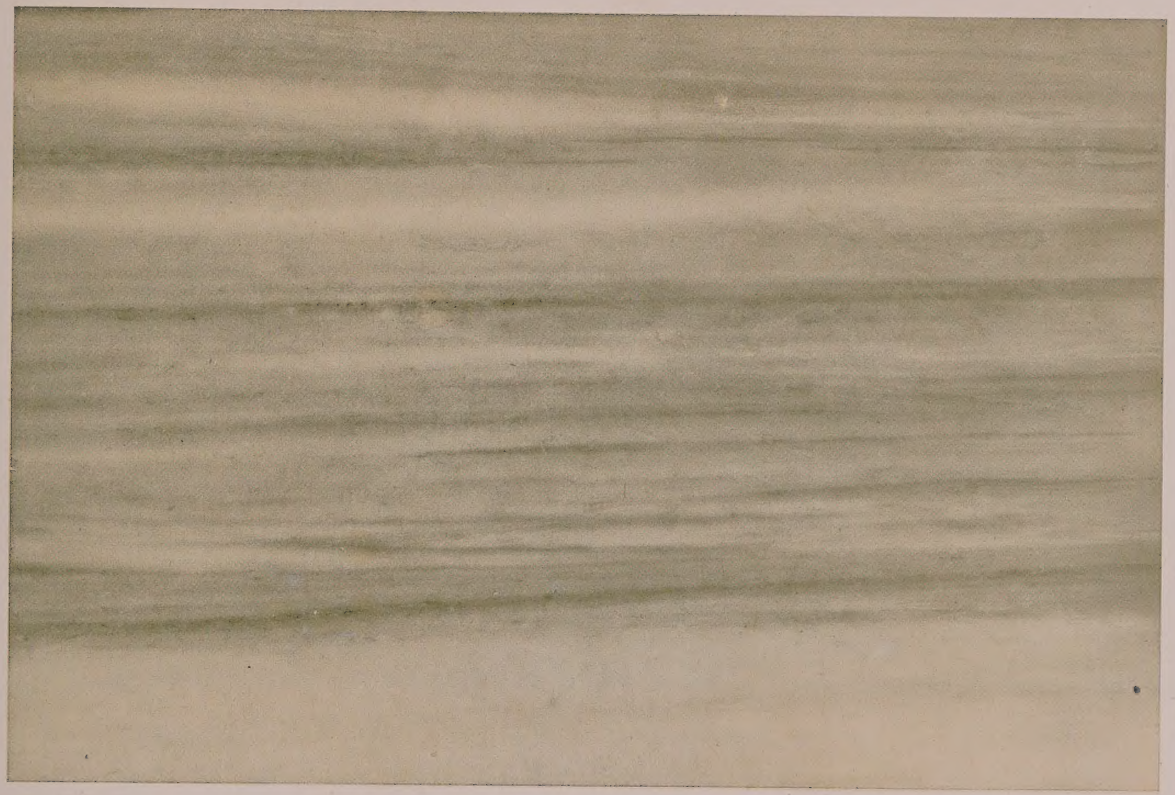
NEWEL SHAFTS OF ROCKLEY MARBLE. RAIL OF FERNBROOK MARBLE. STEPS OF BORENORE MARBLE. BALUSTERS, MOLONG MARBLE.

(STAIRS, NATIONAL ART GALLERY, SYDNEY.)

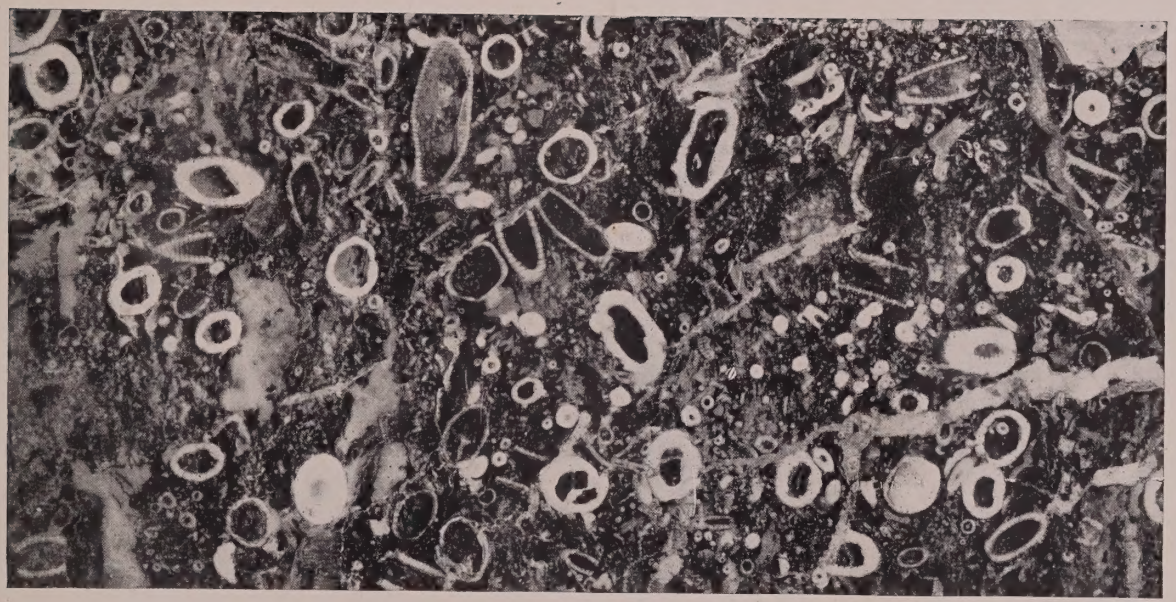


MUDGEE MARBLE, N.S.W.

Half Nat. Size.



QUEANBEYAN MARBLE, N.S.W.



ROCKLEY MARBLE, BATHURST, N.S.W. *Nat. Size.*

MT. GRIMM, Q.—Thirty-one miles W.S.W. of Gladstone.

MT. ROUNDBACK, Q.—Thirty-five miles S. of Bowen. White.

MT. TAMBO, Vic.—A dark bluish fine-grained stone, resembling in colour some of the darkest basalts.

MUDGEE, N.S.W.—Varied coloured marbles are found at Buckeroo, Flirtation Hill, and Sawpit Gully, and many other parts of the district, but undeveloped at present.

NEMINGHA (Tamworth), N.S.W.—One of the finest and most ornate marbles yet unearthed in New South Wales. It is a crinoidal stone of a rich red ground studded with large crinoids, sectioned at all angles. It looks magnificent in columns. Mr. C. F. Laseron has discovered indications of a green variety.

NORONGO, N.S.W.—An outcrop of marble varying in colour from nearly white to dark-blue occurs at this locality, which is about 10 miles from Captain's Flat. The rock is characterised by its remarkable contortion, and, on polishing, this character should give it a peculiar and rare appearance.

ORANGE, N.S.W.—At Douglas occurs a black marble with white streaks.

ORBUST, Vic.—A pretty marble is found here, and is being used to a limited extent in Melbourne. It has a fine wavy or cloudy figure interspersed with a fawn-coloured ground with occasional pink and white streaks and patches. It is certainly worthy of further development.

PARKES, N.S.W.—A variegated and white statuary marble is found at Ashburnham, 4 miles north of Parkes. (*Prof. A. Liversidge.*)

PORTLAND, N.S.W.—Some very fine reddish-coloured marbles are obtained both north and south from this locality.

QUEANBEYAN, N.S.W.—The outcrop is in the form of high bluffs, which flank the Queanbeyan River about 3 miles S. of the town. Unlike most rocks of this nature, it is finely laminated, and splits with a well-defined grain parallel to the lamination. The laminae are very thin and vary in colour, producing varying combinations. White, blue, pale-pink, brownish, and light-green varieties are all common. In places the rock is contorted in an extraordinary manner. Cut at right angles to the lamination, this would make a handsome and rare ornamental stone, and the quantity available is inexhaustible.

ROCKLEY, N.S.W.—A beautifully sound, black and white, crinoidal marble, but has not been developed commercially to any extent. Some samples of it can be seen in the staircase of the Sydney Art Gallery. It is superior to the imported St. Anne's marble.

ROSEDALE, Q.—Jones' Quarry, near Rosedale railway station. 34 miles N.W. of Bundaberg. Blue and white.

At Ritchie's Wolfram claim, near Rosedale, white.

RYLSTONE, N.S.W.—This district is rapidly coming to the front in connection with its marbles, and at present several beautiful and unique varieties are in the course of being placed upon the market. The principal of these are as follows:—

(*a*) *Austral Black.*—Situated on the Carwell Creek. Dark grey and black veined with white, one variety being almost identical with the French "Grande Antique." It is very sound, and can be obtained in large blocks free from faults.

(*b*) *Cudgegong Ivory.*—This is found at Cudgegong, in the same district. It is an ivory-coloured marble of remarkably fine grain, ranging in colour from a delicate cream with dark veins through coral pink to red with chocolate veinings. The beautiful tints of this marble are very effective when polished. It is especially suited for soda fountains. There is a good quantity available.

(*c*) *Cudgegong Golden.*—Found at Cudgegong. This is a yellow marble of great beauty and soundness. It has a warm brownish yellow ground with lighter rings and veins. The grain is extremely fine, and it can be compared very favourably with the well-known "Giallo Antico." It can be supplied in fair-sized blocks free from faults.

(*d*) *Carwell Satin Grey.*—This is a marble of highly decorative effect, with a very fine grain, and easily worked. The ground is composed of dark satin-grey clouds, interspersed with lighter patches, a very faint rose vein being apparent

Rylstone, N.S.W.—*contd.*

here and there. This is in many ways a unique marble, and can be obtained in blocks of fair size.

(*e*) *Roxburgh Rose.*—There are two varieties of this, which is a breccia, one with a small, and the other with a large figure. The ground is red, interspersed with patches of grey brown and blood colour, and the marble is eminently suited for rich decoration on a large scale. (*M. Ferranti.*)

SAWPIT, N.S.W.—*See* Mudgee.

SPRINGHILL, N.S.W.—This is a beautiful black marble, with well-marked fossil shells. It takes a beautiful polish, which gives a depth of reflection quite characteristic. Although passing commercially under this name, it really comes from Waldegrave.

TARAGO, N.S.W.—The matrix in this material is black with white yellow sinuous narrow veins.

TAREE, N.S.W.—The extensive limestone deposits of this district have not yet been used for ornamental purposes. They are generally grey, and are often oolitic in structure.

TARRABANDRA, N.S.W.—This belt occurs about 12 miles north of Tumut, and appears to be similar in character to the Gilmore deposit, to which formation it runs parallel, and like that material looks well polished. It was worked by a Melbourne company thirty-six years ago, but after a short time work was discontinued.

THOMSON RIVER, Vic.—Here is a marble equal in almost every respect to Toongabbie.

RYLSTONE MARBLE, N.S.W.

Nat. Size

RYLSTONE MARBLE (CUDGEGONG GOLDEN), N.S.W.

SPRING HILL MARBLE, N.S.W.

Nat. Size.

SPRINGHILL MARBLE, N.S.W. *Nat. Size.*

Half Nat. Size.

WARIALDA MARBLE.

N.S.W.

Half Nat. Size

WARIALDA MARBLE

N.S.W.

WINDELLAMA MARBLE, N.S.W.

TOONGABBIE, Vic.—This is a good decorative stone which may be classed with the black varieties of marble with white crinoids, and resembles the Rockley of New South Wales.

TOWNSVILLE, Q.—A white saccharoidal marble occurs in a mountain near Double Barrel Creek, 27 miles S. of Townsville. Grey and of fine quality, from 30 miles S. of Townsville. Northern railway, white, saccharoidal on hill west of Read Creek railway station, 30 miles S. of Townsville.

TUMUT, N.S.W.—A richly variegated variety of marble.

WALLI, N.S.W.—A little-known material.

WARATAH BAY, Vic.—A fine black marble with white streaks occurs here.

WARIALDA, N.S.W.—Although this is quite a new field, it promises to be a great centre in producing ornamental and building marbles of good quality. A white ground marble with black lines, and a red and white stone are the two principal kinds yet developed. These are very ornamental. Mr. M. W. Hardy, of Narrabri, kindly supplied the material for the coloured plates.

WARRNAMBOOL AND SORRENTO, Vic.—Late Tertiary and sub-recent limestones of Æolian origin have been sawn into blocks for house building. (*Chapman.*)

WAURN PONDS, Vic.—A stone much used in Victoria in public buildings such as Working Men's College. St. Paul's Anglican Cathedral, Ormond College, It has a dark yellowish tint, or buff colour, and darkens in colour on exposure.

WEE JASPER, N.S.W.—There is an extensive deposit of a dark-coloured limestone in this locality, but a large portion of it will be covered by the waters of the Barren Jack Reservoir.

A much better marble occurs about 4 miles south from this, on the banks of the Little River. It is fine and even in grain, but has not been worked, so no further data can be given.

WINDELLAMA, N.S.W.—A large deposit of dense black marble outcrops on Windellama Creek, 2 miles from the Post Office. There is an unlimited quantity available, and it is the best black marble yet found in New South Wales. It is easily quarried into slabs, which are very sound.

WOMBEYAN CAVES. N.S.W.—A white saccharoidal marble occurs here in enormous quantities, but is as a rule somewhat coarse.

YARRANGOBILLY, N.S.W.—A little-known marble.

YASS, N.S.W.—A quarry of white and variegated marble is worked at Coolalie by Mr. James.

The district is well favoured in its limestones. There is a handsome black variety on the hill to the west of the town, which appears suitable for building.

A fossiliferous variety outcrops at Hatton's Corner, 2 miles from Yass. It is entirely constructed of corals and other organisms. Polished, the coral has a very ornamental character, and it should do well for mantelpieces and mural decorations.

All the Queensland localities are those given in Dunstan's Queensland Mineral Index, 1913.

IX.—Slate.

AUSTRALIA is undoubtedly possessed of good roofing slates, but until recently little information has been obtainable as to the extent of the various deposits, and also of the quality of stone available. However, there has been lately a forward movement in this direction, and from evidence produced there seems likely to be a large development in the near future. From the vast areas in Australia which are characterised by slate country, good building slates have long been known ; and now several varieties are to hand which undoubtedly must be considered as excellent roofing slates, comparable with those at present imported from other countries. At present Mudgee and Chatsbury, near Goulburn, in New South Wales, are localities where good roofing slates are known to occur.

Several localities are given in the Geological Records of Victoria of the occurrence of a roofing slate, but so far none has been developed into a commercial success.

Mintaro, in South Australia, supplies a good flagging material to Adelaide and other towns of that State.

Slate of a more or less commercial value occurs in most of the States, but quarrying is not much developed at present.

BUNGENDORE, N.S.W.—It has been reported that a slate in a form capable of being split into large slabs occurs about 5 miles south-east of Bungendore on the Captain's Flat Road. It is also stated, however, that it is somewhat soft and might be useful for flagging, but requires investigating regarding its economics.

CHATSBURY, N.S.W.—This locality is 19 miles from Goulburn, and 7 miles from Forest Siding, Crookwell Line.

Chatsbury, N.S.W.—*contd.*

(1) A dark hard slate with a warm brownish tint, splitting into thin excellent roofing slates. At present being worked by Mr. J. Turner, Goulburn.

(2) A greenish-grey slate of pleasing appearance, splitting readily into good thin slates, suitable for roofing, but occasional small crystals of pyrites detract somewhat from its value.

SLATE.

(CHURCH OF ENGLAND, BREADALBANE, N.S.W.)

MINTARO SLATE FLAGGING (SOUTH AUSTRALIA).

COOMA, N.S.W.—A large deposit of slate outcrops near the Adaminaby Road, 11 miles W. of Cooma. The rock is blue in colour, hard, and splits readily into slabs $\frac{1}{16}$ of an inch in thickness.

It should make good pavement flags and steps.

GRATTAI, N.S.W.—Ten miles from Mudgee.

A dark hard slate, splitting easily into thin plates with lustrous surfaces, suitable for roofing.

GUNDAGAI, N.S.W.—A slate quarry has been opened near this township, and there is any quantity of material available. The rock is hard, with a good surface, but the cleavage is hardly fine and regular enough in the material examined. Better results may yet be obtained when investigated on a more extensive scale.

JERRAWA, N.S.W.—There is a fairly extensive slate deposit about 3 miles east of this town. It is difficult to give an opinion on its qualities as only surface material is procurable, which, however, is fissile, splitting easily into very thin leaves.

Jerrawa, N.S.W.—*contd.*

The indications are that at a lower depth it might prove a satisfactory slate.

MINTARO, S.A.—These quarries are situated 83 miles north of Adelaide, and the material obtained is being extensively used for flagging, &c., for which it is very suitable, in the State of South Australia. It does not split readily, so is not used for roofing.

QUEANBEYAN, N.S.W.—From 4 to 5 miles from the township on the Cooma Road, slates, splitting readily into thin slabs with good lustrous surfaces, outcrop. The weathered nature of the specimens examined renders it impossible to estimate its quality below the surface.

TARALGA, N.S.W.—At Currawang Creek there is a deposit of blue slate suitable for flagging and roofs, especially the latter, for in colour it equals the best blue Welsh. (*J. Turner.*)

TOWRANG, N.S.W.—A slate quarry was opened here many years ago, but has not since been worked.

X.—Serpentine.

AUSTRALIA is evidently very rich in this material, but so far it does not appear to have received any particular attention except in New South Wales, where the following are the best known districts from where this material can be obtained, but not much attention even in these has so far been given to its development.

The material from the different localities is of an ornamental character, various shades of green being the predominating colour, and New South Wales Serpentine will no doubt be used in our architecture of the future as a decorative stone.

As a rule, the deposits run in belts, extending for the most part considerable distances, and in the case of the Warialda-Bingera-Nundle belt for about 150 miles.

This northern belt is of great extent, but many of the outcrops are much weathered, so that there are comparatively few localities where the surface stone is of sufficient solidity to make it profitable to work for ornamental purposes.

Around Nundle there is a considerable development, and the geological aspect of the series has been dealt with by W. N. Benson (Three papers, Proc. Linn. Soc. N.S.W., 1913). From here the belt extends in a broken fashion northwards, outcropping to the east of the townships of Manilla, Barraba, Bingera, and Warialda. At the latter place a considerable outcrop is found about 3 miles to the eastward along the Inverell railway line, and the rock is for the most part of a mottled green colour with some blue, and should polish well.

In the western portion of New South Wales Serpentines are extensively found at Lucknow, where they are associated with rich, gold-bearing ores, but as ornamental stones their economics are as yet untried.

In the south there is a considerable belt of Serpentine outcropping on the railway line at Gundagai. The rock is here a deep mottled green, and polishes well. From Gundagai the belt extends in a south-easterly direction through Tarrabandra, and crosses the Goodradigbee Road, 16 miles from Tumut. At both these localities the rock is a dark mottled green.

On the North Coast, at Port Macquarie, occurs one of the largest and, so far, the most accessible outcrop of Serpentine. The rock here forms cliffs and headlands bordering the sea coast, and also occurs in scattered localities throughout the district, so that any quantity of stone is available. Though the material is often somewhat weathered on the surface, in many places the outcrop is more solid, and large blocks are immediately obtainable. The colour is for the most part a beautiful dark mottled green, but shades of lighter green, blue, and other tints are common.

Amongst the other States, Queensland seems to have the greatest possibilities in this direction, for although Serpentine has not yet been worked for ornamental purposes, yet very many large deposits are known, "which could furnish very good material for this purpose." Several of these are listed in Dunstan's "Mineral Index," and perhaps the one possessing the most immediate possibilities is the large belt to the north-east of Rockhampton.

CANOONA, Q.—Large deposits of serpentine occur in this district, but their economics are unknown.

GUNDAGAI, N.S.W.—A material similar to that of Tarrabandra is abundant in and around Gundagai, but requires further exploiting. When polished takes a deep green colour, and looks very well.

KANDANGA, Q.—At this locality, south-west of Gympie, a large belt of serpentine extends for many miles.

MACLEAY RIVER. N.S.W.—A compact, green serpentine occurs in this locality, which takes a high polish, and should be valuable for decorative purposes.

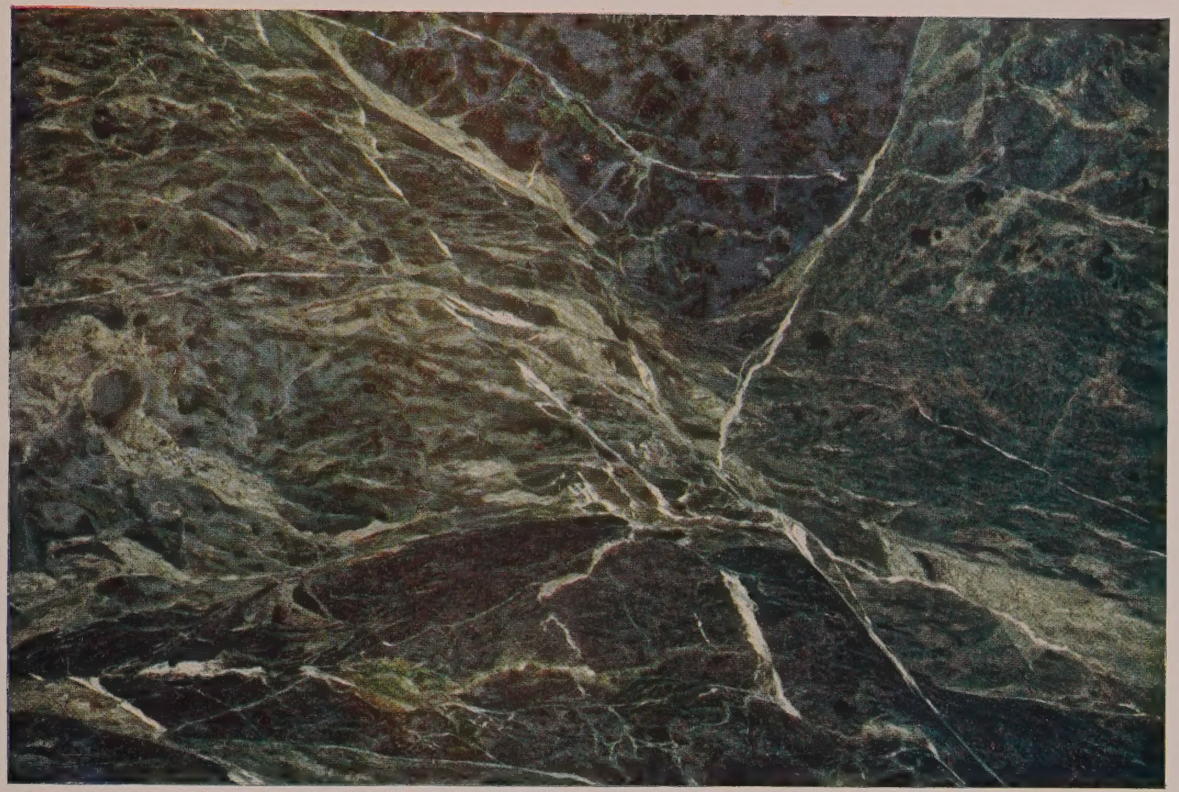
PORT MACQUARIE. [See above.]

ROCKHAMPTON, Q.—A very large deposit of good serpentine occurs to the north-east, but is as yet unworked.

TARRABANDRA, N.S.W.—A dark olive-green coloured, mottled serpentine is found here running in a north-west and south-east direction. Only surface material was available for examination, but the indications point to the presence of good serpentine.

TUMUT, N.S.W.—A belt of blue and green serpentine crosses the main road some 16 miles north-east of Tumut, and is probably a continuation of the Gundagai belt, running as it does in a north-west and south-east direction.

PORT MACQUARIE SERPENTINE, N.S.W.
[WHITE VEINED.]



PORT MACQUARIE SERPENTINE, N.S.W.
[SHOWING BLUE TINT.]

XI.—Quartzite.

BURROWA, N.S.W.—An outcrop of quartzite is found about 9 miles from Burrowa, on the Young Road. The rock is fissile, splits readily into slabs, and is used for flagging in the township.

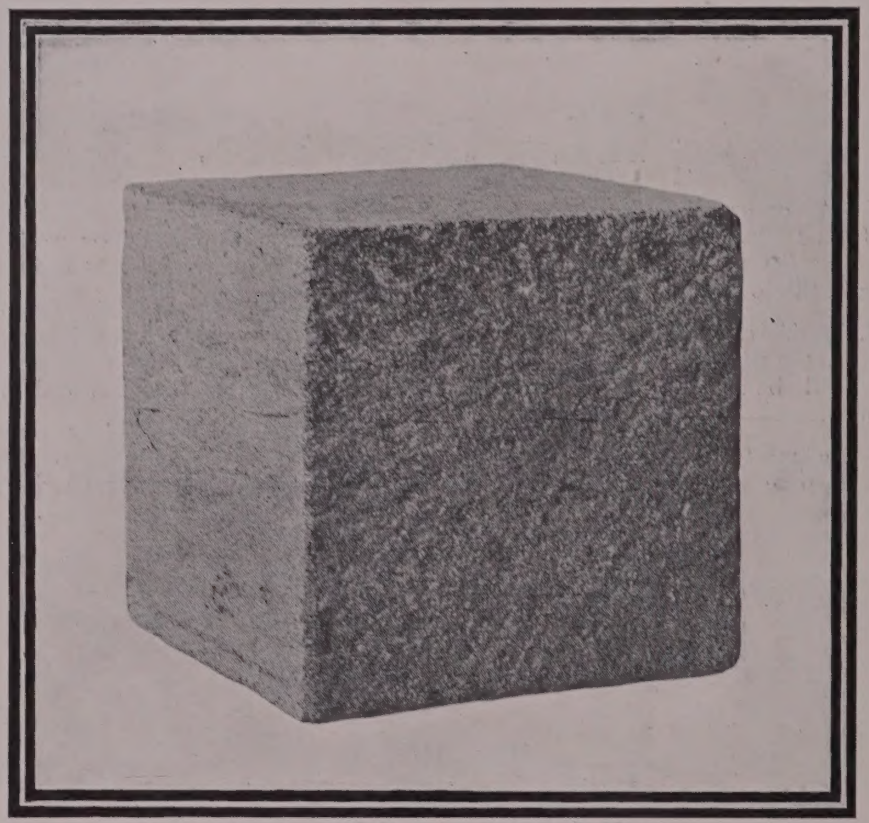
QUEANBEYAN, N.S.W.—This is an abundant stone in this neighbourhood, the white varieties having been used in commercial buildings and ecclesiastical edifices in the town.

TARAGO, N.S.W.—The most common rock at this locality is a hard, pure white quartzite. It has,

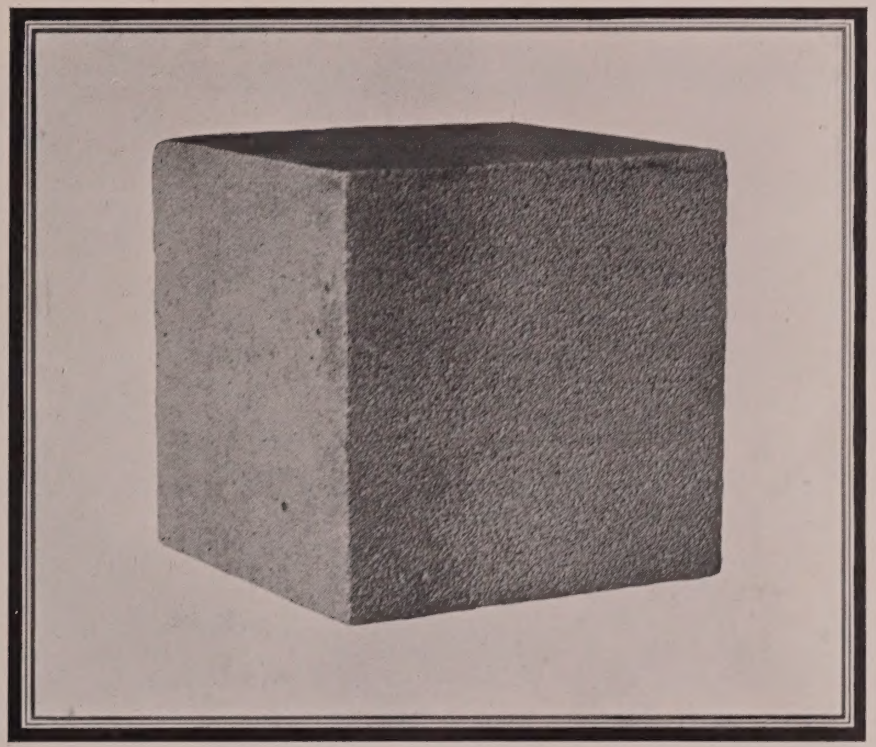
Tarago, N.S.W.—*contd.*
however, not yet been worked, but being available in any quantity might be useful in the future.

TARRABANDRA, N.S.W.—There is a peculiar form of foliated quartzite at this place, but so jointed at the surface that only small specimens are available. Mr. Harlow's house is built of this material.

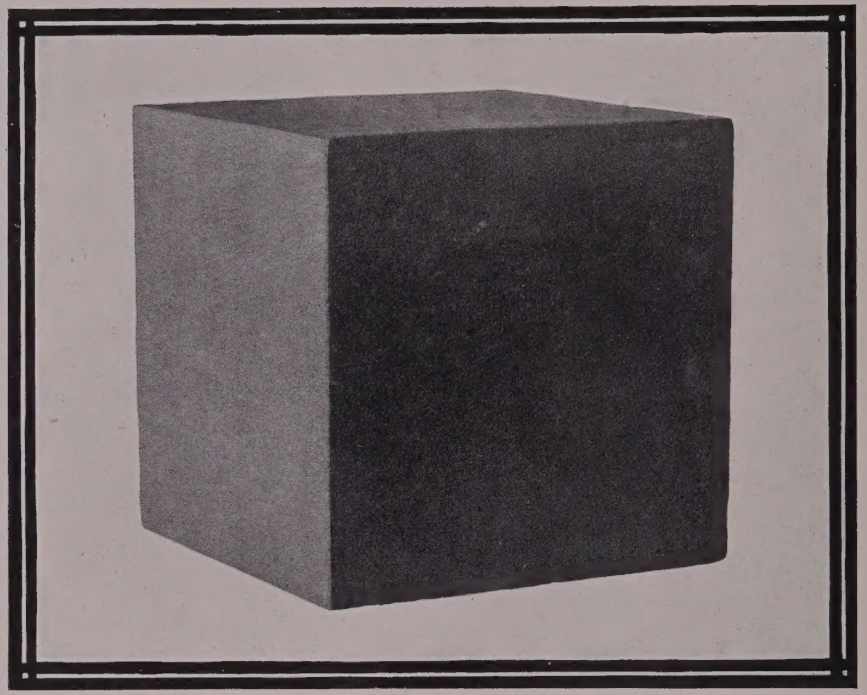
URIARRA, N.S.W.—A large outcrop of massive, dark-red quartzite, outcrops on the Murrumbidgee River at its junction with the Uriarra to Queanbeyan road.



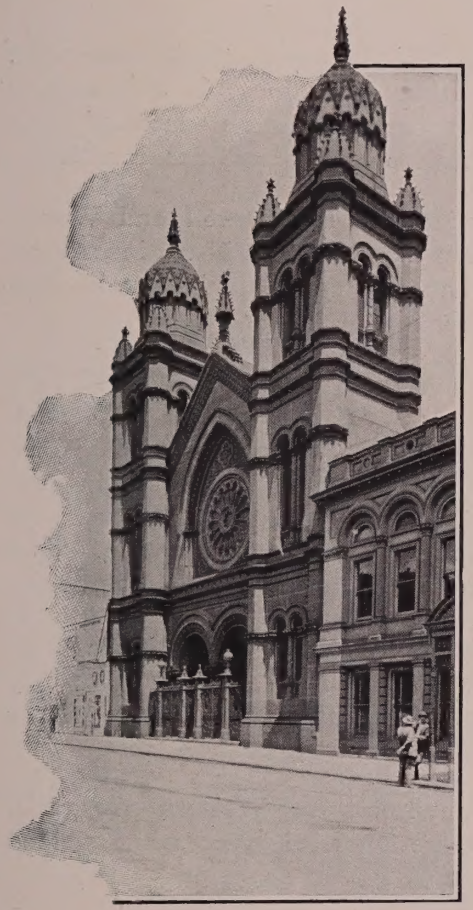
SYDNEY SANDSTONE 3 IN. CUBE.



BUNDANOON SANDSTONE, 3 IN. CUBES.
(N.S.W.)



RAVENSFIELD SANDSTONE, 3 IN. CUBES.
(N.S.W.)



SYDNEY SANDSTONE.
(JEWISH SYNAGOGUE SYDNEY N.S.W.)

XII.—Sandstone.

AUSTRALIA, as a whole, is very fairly provided with building material of this nature, varying, of course, in colour and texture according to its geological age. Of all the States, New South Wales is especially favoured in this direction, for in the neighbourhood of Sydney itself and extending away to the Blue Mountains, as well as far north and south, is obtained the finest building sandstone of the whole continent. Its quality is such that it is imported into all the States, and figures largely in architectural work in all the capitals and large towns, being a great favourite with the stonemason and architect.

The position of Victoria in this connection is, perhaps, best told in the words of Mr. H. S. Richards, M.Sc., in the introduction of his paper on "Victorian Sandstones":—

> "Although Victoria is a country rich in various mineral deposits, it has not up to the present yielded a sandstone with properties which have rendered its adoption to any extent for building purposes. The want of a good cheap Victorian freestone is at present severely felt by Victorian architects; and although many stones have been tried at different times in Melbourne, one having the combination of good weathering and economical dressing properties has not been obtained."

SYDNEY SANDSTONE.
(MEDICAL SCHOOL, SYDNEY UNIVERSITY, N.S W.)

Thus the discovery ot a good sandstone, comparable to that of Sydney, is still a desideratum with the southern State, as most of those known are either too hard or are not durable.

The best so far are Stawell and Waurn Ponds, and these have been utilised in several of the most important public buildings in Melbourne and other Victorian towns.

Tasmania is, perhaps, more favoured than her northern sister, Victoria, for we find such buildings in Melbourne as the Town Hall, Law Courts, and Industrial Museum made in part from Tasmanian sandstone, which appears to weather well and give satisfaction, and in "the early days was extensively used in Melbourne."

Queensland and South Australia have so far not developed any building sandstone, Sydney stone being used, as it is cheaply obtained and easily worked.

At Donnybrook, in Western Australia, three varieties are quarried, viz., white, veined and pink.

SYDNEY, N.S.W.—Sydney from its geographical position is, therefore, in the matter of excellent sandstone, particularly well served, for it has at its very door, so to speak, an inexhaustible supply; and it must have been a source of satisfaction to Governor Phillip, when founding the city, that such an area of building material was so close at hand.

Sydney proper is practically built on a sandstone formation, known geologically as the "Hawkesbury Sandstone," called after the river of that name, which in the greater part of its course runs through this formation.

From the foundation of the city to the present day this sandstone has been extensively used in buildings, being specially well adapted for architectural and ornamental work, as it can be sawn and carved with ease, and after being freshly cut, tones down to a light straw colour, which it retains for an indefinite period. It is composed of small particles of waterworn quartz, with a cementing medium of varying constituents, the whole deposit probably originating from a disintegrate granitic range of mountains in past geological times.

Much might be written on the adaptability of this stone for building purposes, which has contributed so largely to the architectural beauty of Sydney,—the first city of Australia.

The following are some of the more important edifices constructed from this stone :—

Sydney Town Hall ;
General Post Office ;
Sydney University ;
Fisher Library ;
Mitchell Library ;
Public Library ;
Art Gallery ;

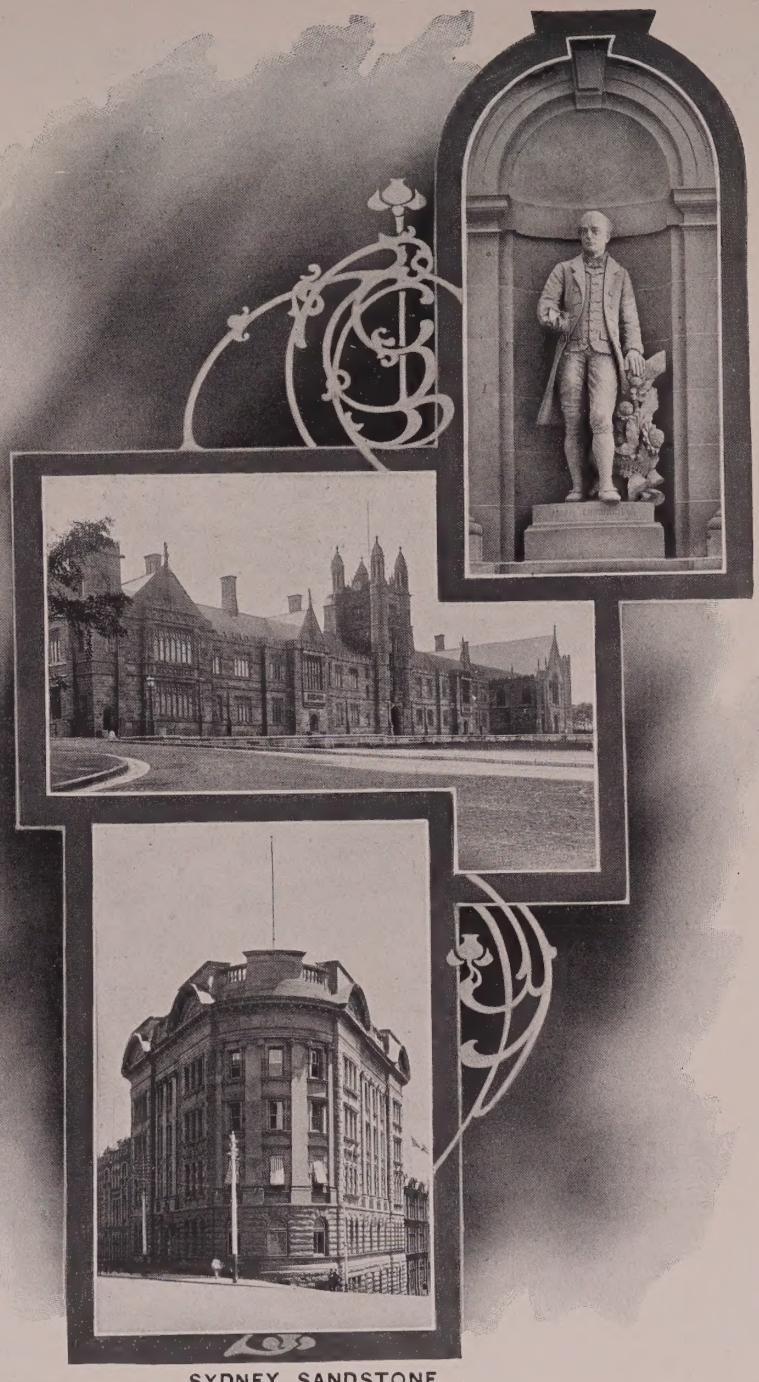
And many large business and private dwellings, as well as Cathedrals and Churches.

1 Roman Catholic Church, Yass. Built of Local Sandstone

Church of England, 2. Canberra. Built of Sandstone and Quartz Porphyry.

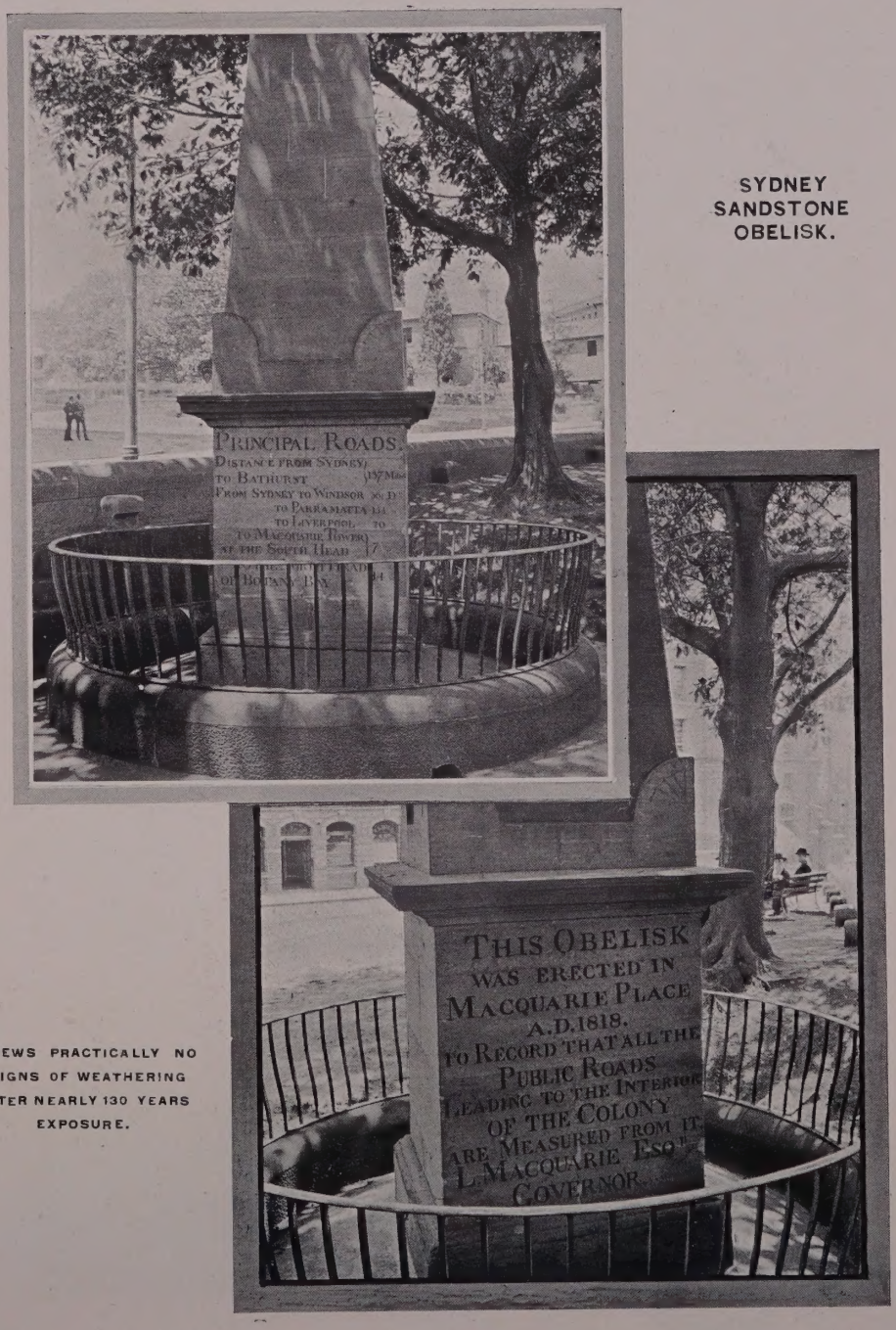
3 Roman Catholic Convent, Yass. Built of Blue Calcareous Sandstone.

VARIOUS NEW SOUTH WALES BUILDING MATERIAL.



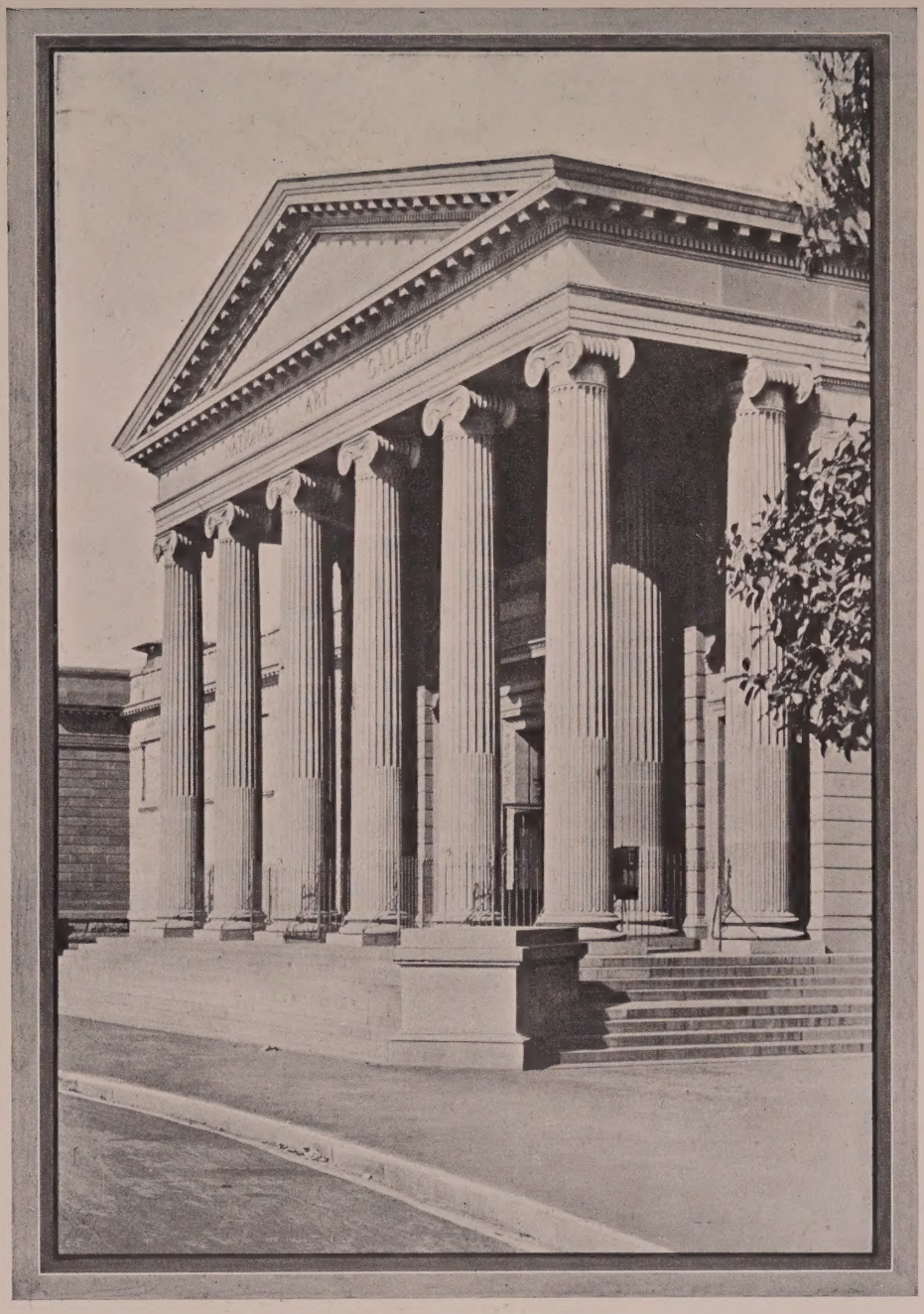
SYDNEY SANDSTONE.

(STATUE ALLAN CUNNINGHAM.) (SYDNEY UNIVERSITY.)
(COLONIAL SUGAR CO.'S OFFICE.)



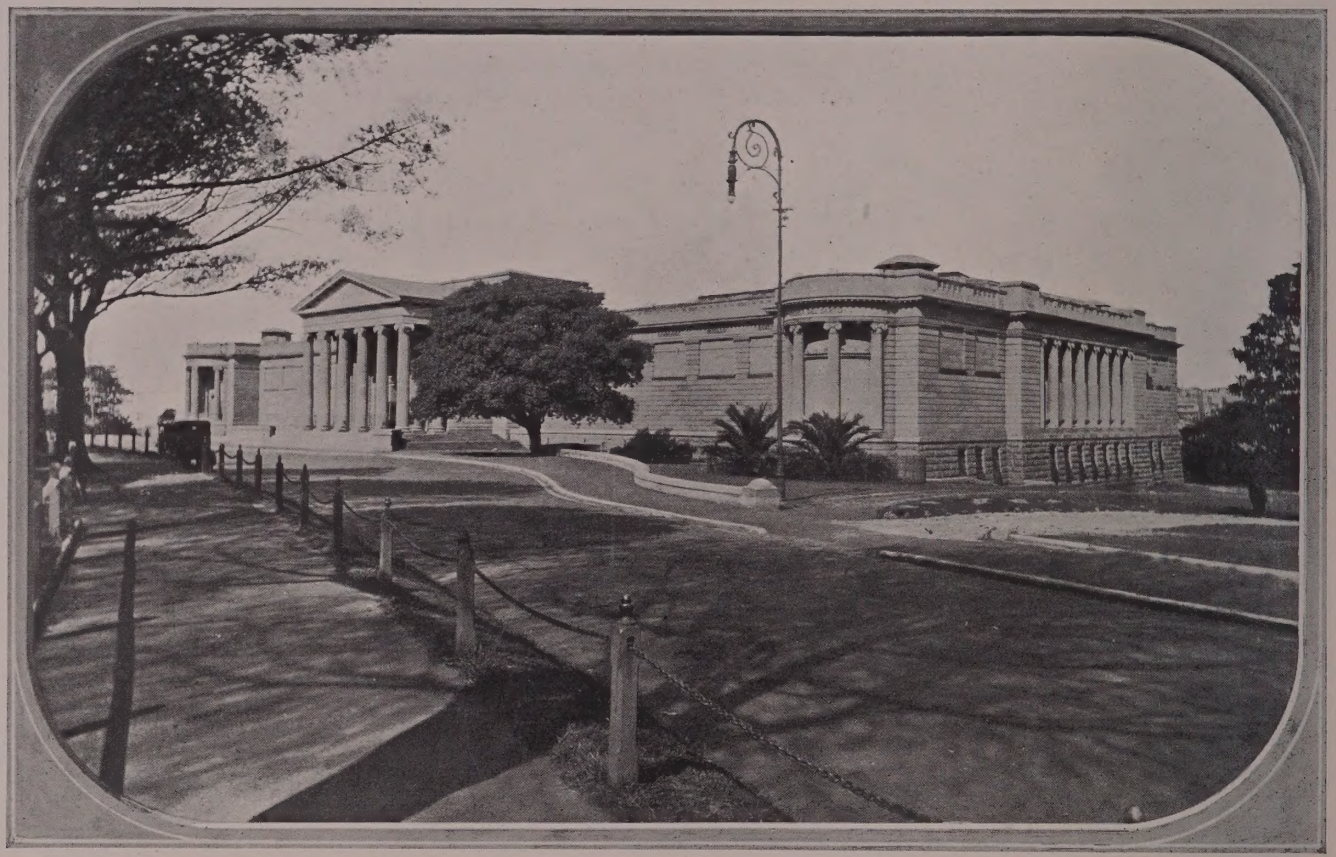
SYDNEY SANDSTONE OBELISK.

SHEWS PRACTICALLY NO SIGNS OF WEATHERING AFTER NEARLY 130 YEARS EXPOSURE.



SYDNEY SANDSTONE.

(NATIONAL ART GALLERY, SYDNEY, N.S.W.)



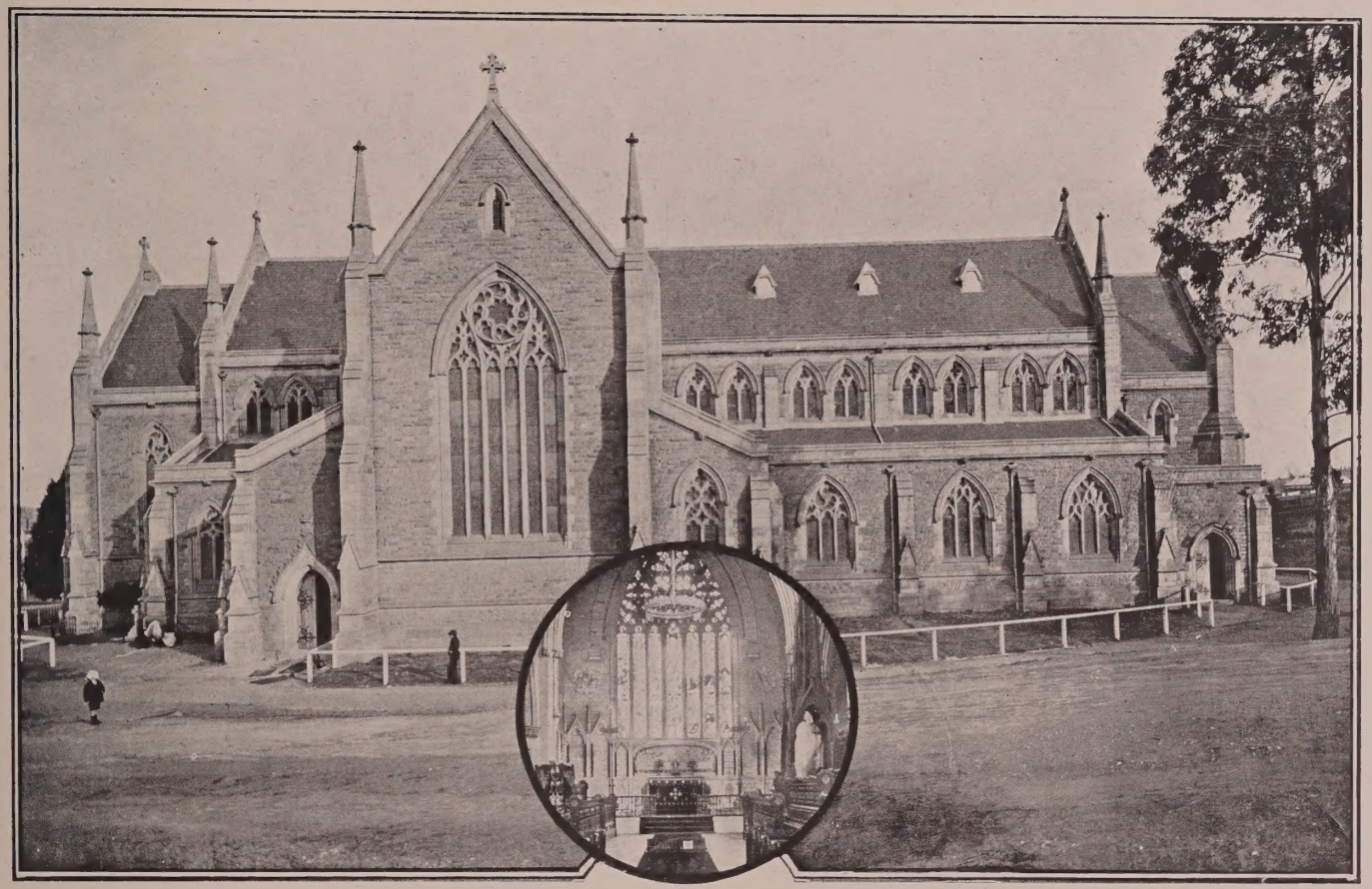
SYDNEY SANDSTONE.

(NATIONAL ART GALLERY, SYDNEY, N.S.W.)

SYDNEY SANDSTONE.
(TOWN HALL SYDNEY, N.S.W.)

SYDNEY SANDSTONE.

(ST. ANDREW'S CATHEDRAL, SYDNEY, N.S.W.)



MARULAN SANDSTONE.

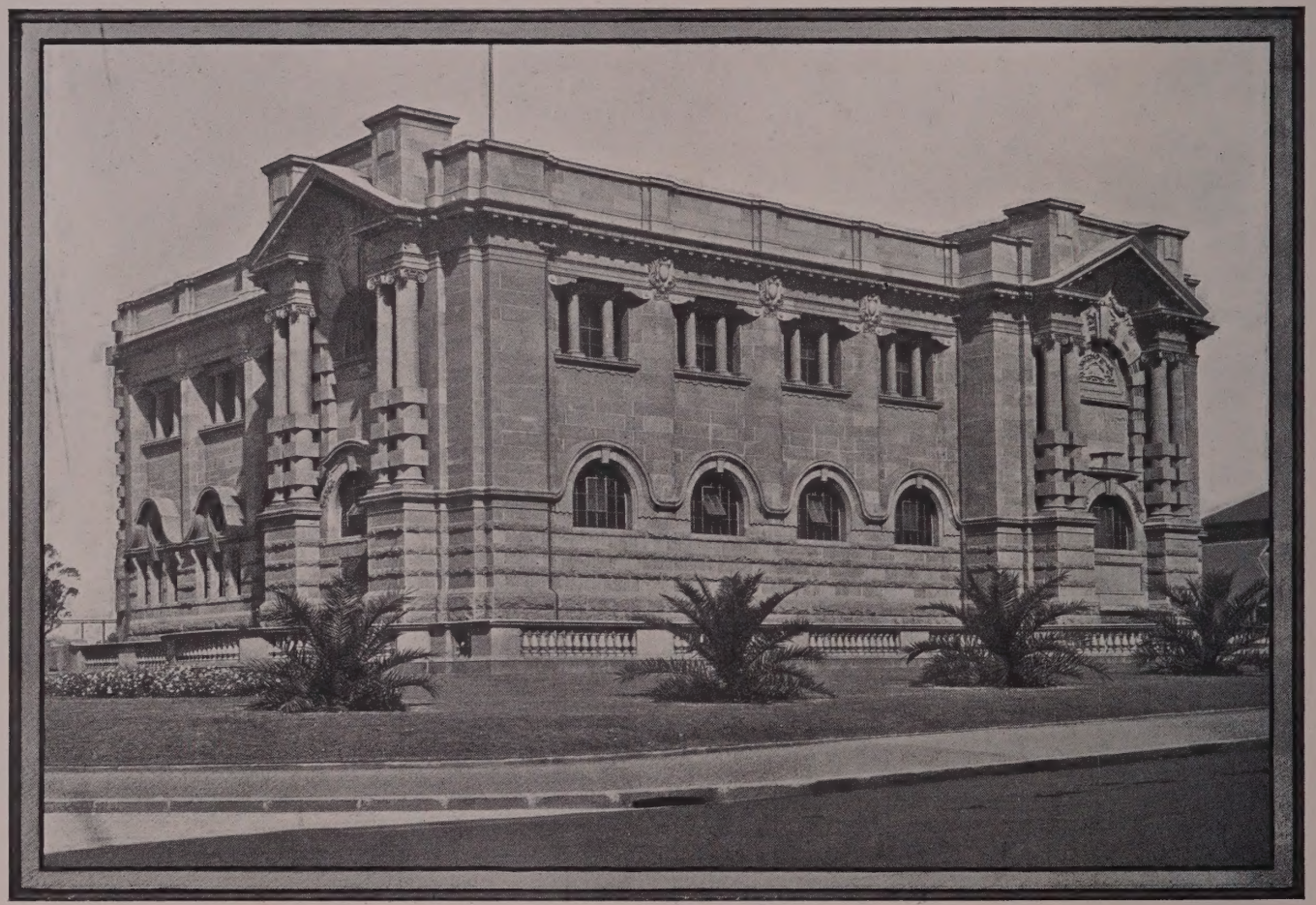
(ST. SAVIOUR'S ANGLICAN CATHEDRAL, GOULBURN. N.S.W.)

SYDNEY SANDSTONE.

(ST. MARY'S CATHEDRAL, SYDNEY, N.S.W.)

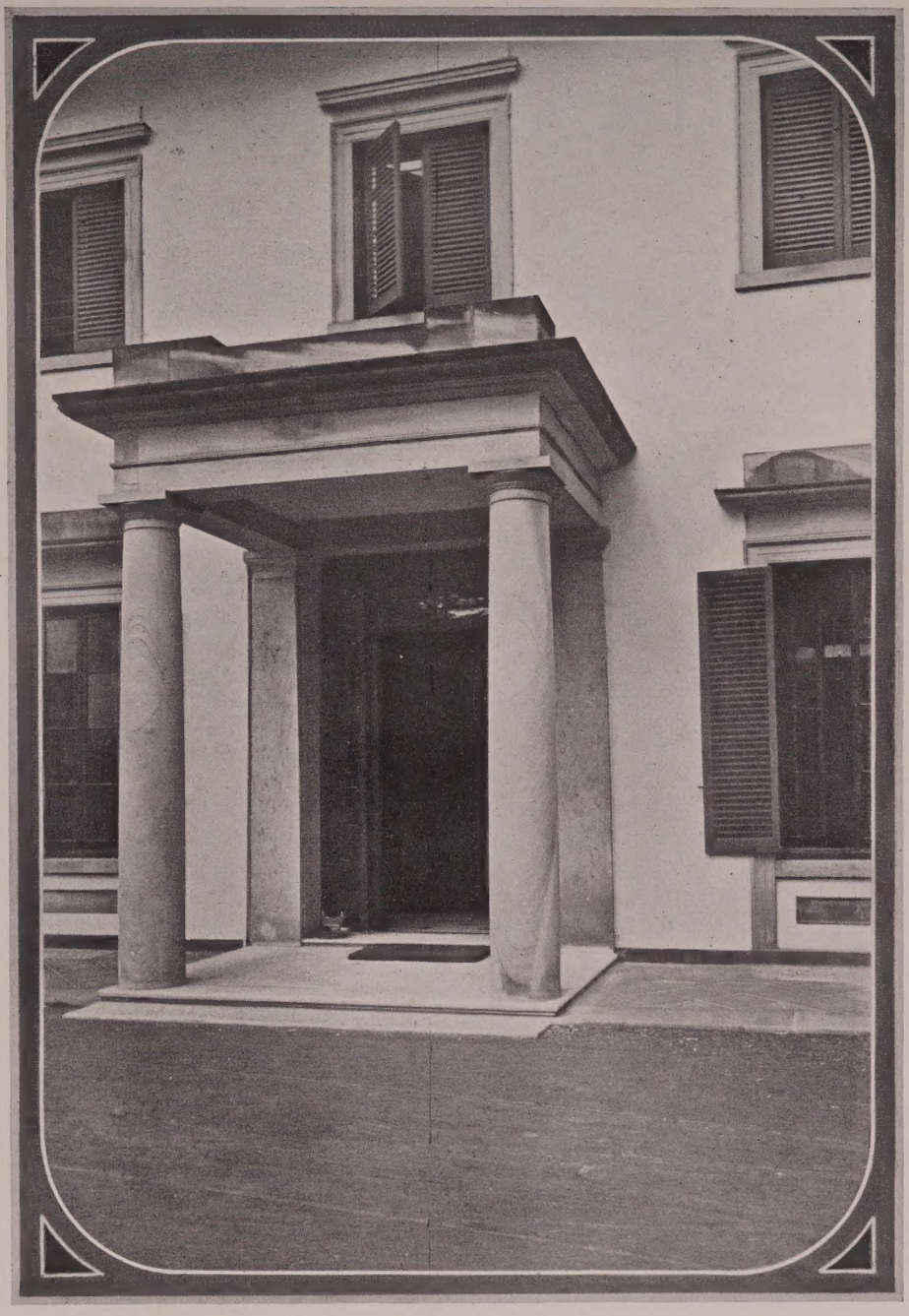
SYDNEY SANDSTONE AND BOWRAL TRACHYTE.

(VICTORIA BUILDINGS, SYDNEY, N.S.W.)



SYDNEY SANDSTONE.

(MITCHELL LIBRARY, SYDNEY N.S.W.)



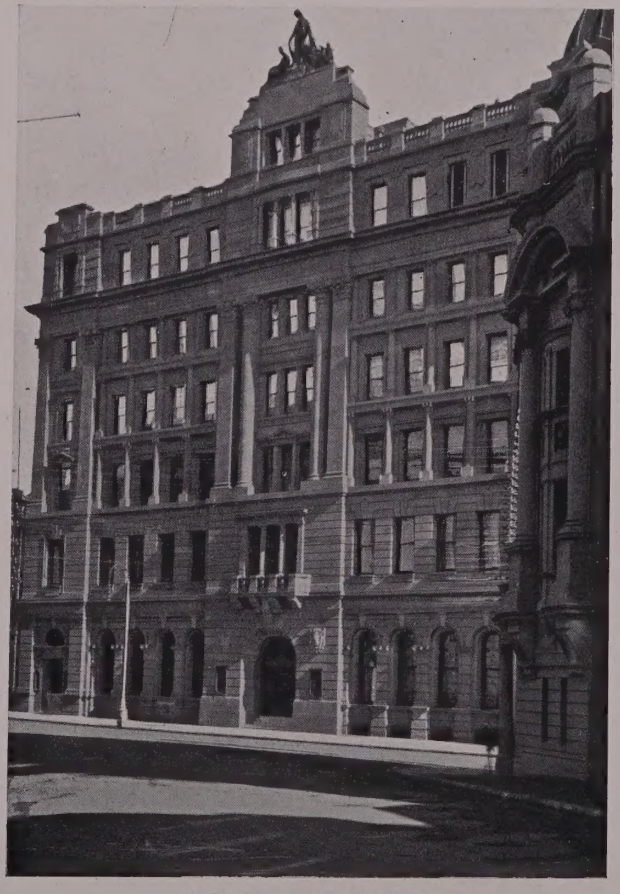
MARULAN SANDSTONE.

(PORTICO, CAMDEN HOUSE N.S.W.)

SYDNEY SANDSTONE.
(BANK OF ADELAIDE, S.A.)

SYDNEY SANDSTONE.

(REGISTRAR-GENERAL'S OFFICE, SYDNEY, N.S.W.)



SYDNEY SANDSTONE.
(A.M.P., SYDNEY, N.S.W.)

SYDNEY SANDSTONE.
(LANDS DEPARTMENT, N.S.W.)

ALBURY, N.S.W.—At Albury, at Tabletop, there is an excellent, hard, red sandstone intermixed with water-worn pebbles.

APOLLO BAY, Vic.—This is a nice, even-grained close-textured stone of a greenish tint, and is worthy of a trial at the hands of the Melbourne architects. It has been used in the construction of Cape Otway Lighthouse.

BARBER'S CREEK, N.S.W.—The sandstone of this locality is of good quality, although occurring in narrow layers separated by intervening pebble beds. (*F. Turner.*)

BARRABOOL, Vic.—This is a dark yellowish sandstone that has been used in several important public buildings in Melbourne, such as St. Paul's Cathedral, Working Men's College, &c.

BRAIDWOOD, N.S.W.—At Nerriga there is a fine-grained sandstone.

BUNDANOON, N.S.W.—This is one of the best sandstones in New South Wales for big buildings. It has been used in the Goulburn Court-house, and generally in all buildings of any pretensions in the Southern District. Varies in colour from white to pink. It forms the base and pedestal of the Soldiers' Memorial at Goulburn, the photograph of which was kindly lent by Mr. J. Turner, Goulburn.

CANBERRA, N.S.W.—Several quarries have been opened out in this material, but with hardly satisfactory results, although it has been used in some of the local public buildings. It is stated that the red variety makes a handsome building stone in conjunction with other white stones, such as Canberra and Bundanoon. The Canberra church is built of the white Canberra stone.

DONNEYBROOK, W.A.—A compact light-coloured sandstone, which is coming into much favour for building purposes, is obtained here. (*Maitland and Jackson.*)

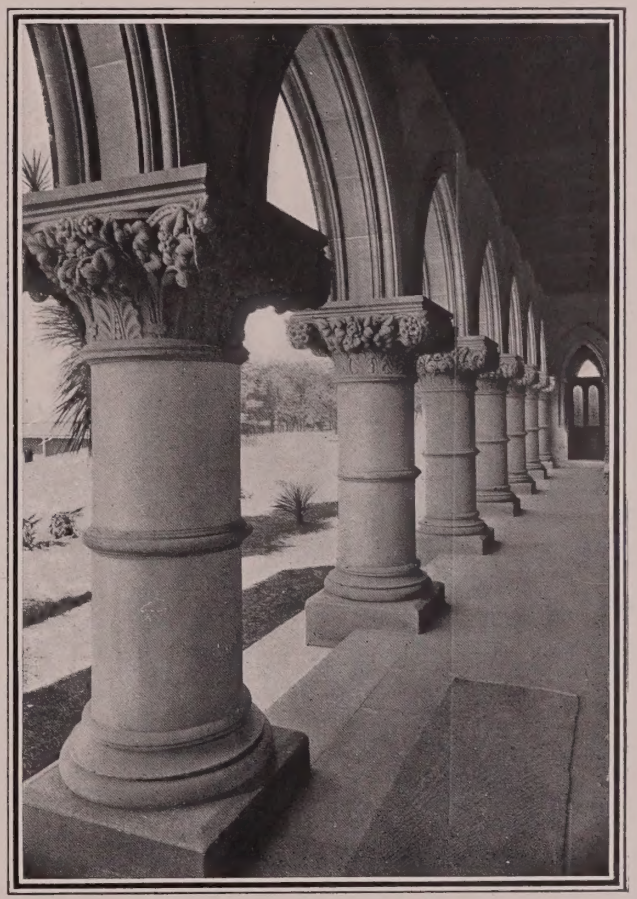
WARATAH CAPITAL OF SYDNEY SANDSTONE.
(NEWINGTON.)

THE "Waratah" (*Telopea speciosissima*, R.Br.) is the national flower of New South Wales.

It is probably the most gorgeous amongst the native flora, and its generic name "*Telopea*" (seen from afar) is most happily chosen.

What the Lotus was to the Egyptian, and the Acanthus to the Greek, in architectural decoration,—the Waratah promises to be to the Australian.

In the above capital, carved many years ago, the sculptor has cleverly shown its suitability for decorative purposes.



SYDNEY SANDSTONE.
(THE COLONNADE, NEWINGTON COLLEGE, SYDNEY, N.S.W.)

BARRABOOL SANDSTONE (VIC.), AND
FOOTSCRAY BASALT (VIC.).
(ST. PAUL'S CATHEDRAL, MELBOURNE.)

BUNDANOON SANDSTONE DRESSINGS.
(GOULBURN TOWN HALL, N.S.W.)

FROGSHOLE, N.S.W.—At Frogshole, near Goulburn, there is a sandstone which is quite soft when cut out, but hardens considerably on exposure, and specimens used as base courses in Goulburn show no signs of weathering after forty years.

The sandstones of the Coal Measures themselves, though as a rule unworked, are frequently of a nature adaptable for building purposes.

GALONG, N.S.W.—At this locality is a hard, buff-coloured sandstone, which is excellent for flagging and steps. It has been used for flagging on the platform of the Binalong Railway Station. (*J. Turner.*)

GREENDALE, Vic.—A pale, close, fine-grained sandstone, and apparently from Museum specimens is a good material awaiting trial.

A coarse-grained stone is also found.

GRONG GRONG, N.S.W.—There is a quarry here of hard, red flagging, somewhat resembling that at Galong. It has been used for flagging and kerbstones in the Wagga District. (*J. Turner.*)

HOBART, TAS.—Sandstone is abundant in the vicinity of Hobart, and there are many quarries in the neighbourhood, from which material has been obtained for large buildings in the town. Chief among these quarries are Knocklofty, Domain, Bellerive, Waterworks, Campania, Tea Tree, &c.

MARULAN, N.S.W.—There is a good building sandstone at Marulan, which has long been used in buildings in some of the Southern cities.

MILPARINKA, N.S.W.—In the far interior of the State occurs another deposit of sandstone, known geologically as the "Desert Sandstone,"—an unfortunate term, in my opinion, as it is likely to convey the impression that that part of the State is a "blistering Sahara," when such is not the case.

The term "Milparinka Sandstone" is now suggested for it. At Wilcannia a good sandstone occurs, and has been used in a number of local buildings, including the Prison of the town. (*J. Turner.*)

BACCHUS MARSH SANDSTONE.
(TREASURY, MELBOURNE.)

STAWELL SANDSTONE, STEPS AND BASE COURSES FOOTSCRAY BASALT.

(PARLIAMENT HOUSE, MELBOURNE.)

MUNDOORAN, N.S.W.—There is a sandstone here that is used in local building construction, and is of a very fair quality.

NEWCASTLE, N.S.W.—To the north of Sydney is the coalopolis of the State—*i.e.*, Newcastle; and here the Coal Measures are capped by a sandstone known geologically as the Newcastle Sandstone.

To all intents and purposes this is identical commercially with that found in the neighbourhood of Sydney, and is of equal merit as a building stone.

PATERSONIA, Tas.—From this locality, 15 miles from Launceston, is obtained a good white freestone; St. John's Church, Launceston, being built of it, and also a monument to Lieut. Gunn, which, after fifty years, is said to be still as sound and sharp as when erected. (*O. L. Adams.*)

RAVENSFIELD, N.S.W.—To the same great Permo-Carboniferous formation that the Coal Measures are part of, belong marine sandstones, which differ in composition from the Sydney sandstones, and these are amongst the best in the State. Such is the "Ravensfield Sandstone," worked at Ravensfield, near Maitland.

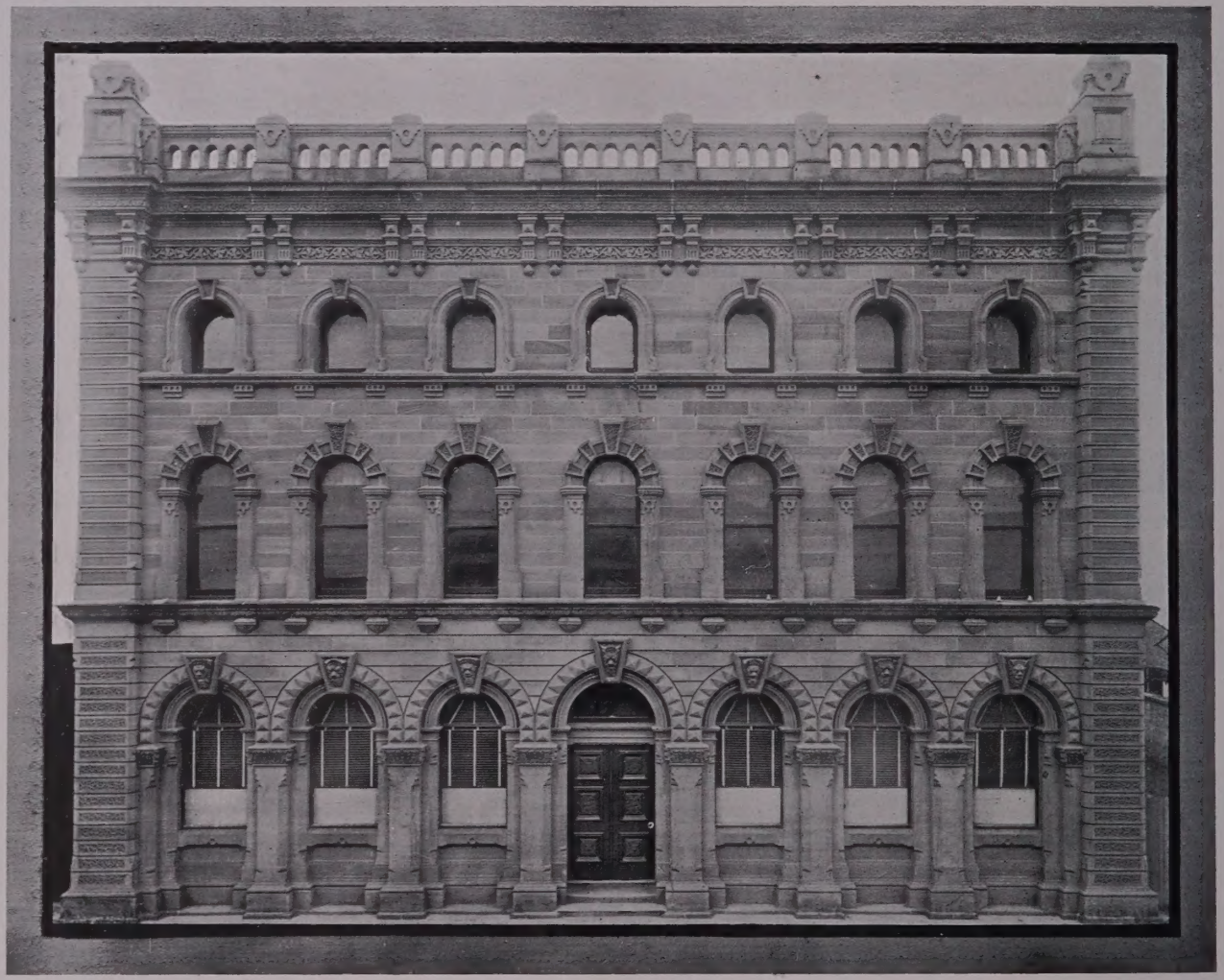
Professor David speaking of this quarry, says:—

The sandstone is from 10 to 12 feet in thickness, of a warm sepia-brown appearance; it is fine grained, a good freestone, easily worked, and is one of the best building stones of its kind as yet found in New South Wales.*

There is also a handsome variety of a fine bluish tint.

Many of the leading buildings in West Maitland are constructed of this stone, which is excellent for carving purposes. It is very little affected by weathering, and the edges of fine carving are still sharp after many years' exposure. The absence of joints makes it possible to obtain blocks of almost any length, and in addition to the building qualities, all these sandstones make good grindstones.

* Geology of the Hunter River Coal Measures. Memoir No. 4, Geological Survey of New South Wales, p. 122.



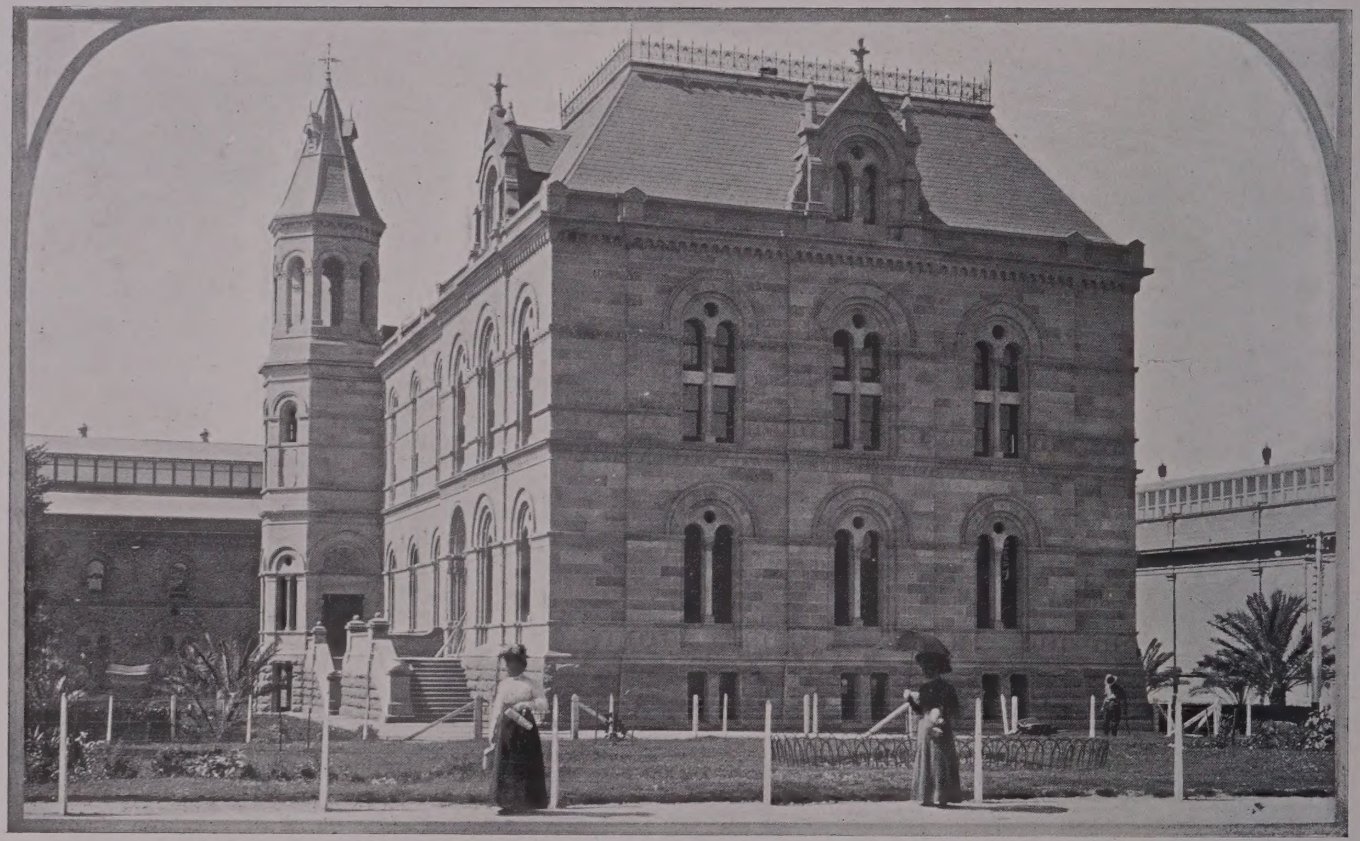
RAVENSFIELD SANDSTONE.
(STRUCTURE, WEST MAITLAND, N.S.W.)

RAVENSFIELD SANDSTONE QUARRY.
(N.S.W.)

RAVENSFIELD SANDSTONE.
(ST. MARY'S WEST MAITLAND.)

UPPER STRUCTURE, MURRAY BRIDGE SANDSTONE, S.A.
STEPS AND BASE COURSES, WEST ISLAND GRANITE, S.A.
ROWS OF COLUMNS, RED DOLERITE, MT. GAMBIER, S.A.

(ST. PETER'S ANGLICAN CATHEDRAL, ADELAIDE, S.A.)



MURRAY BRIDGE SANDSTONE.
(MUSEUM ADELAIDE, S.A.)

MURRAY BRIDGE SANDSTONE AND GRANITE.
(ADELAIDE S.A.)

ROSS, Tas.—From near this town, in the Midlands, was obtained the sandstone from which the local church and the A.M.P. Building, Launceston, are built.

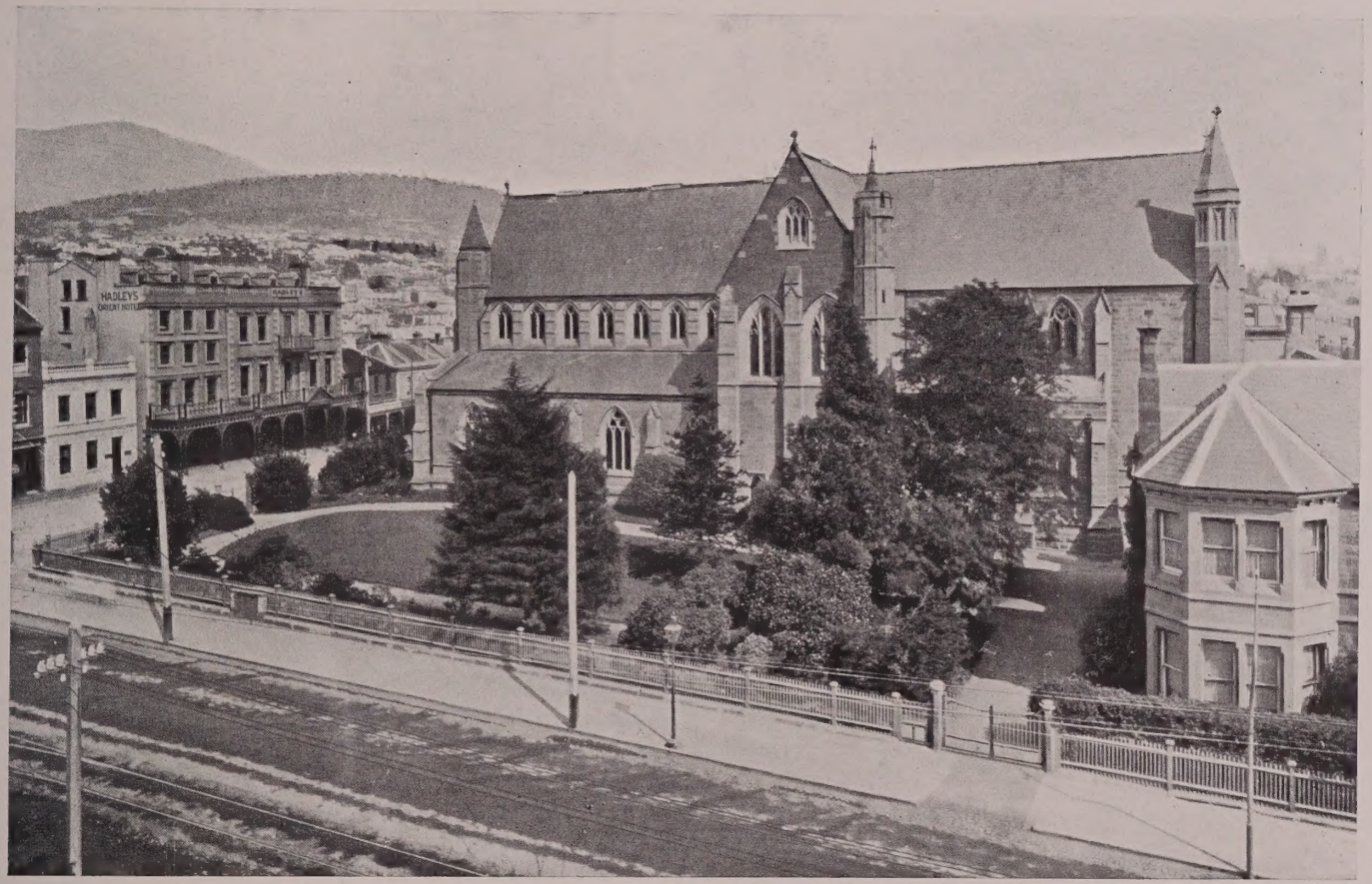
STAWELL, Vic.—A hard close-grained material of a fresh pale colour when first cut, which tones down considerably upon exposure, and ultimately discolours by the action of a city atmosphere. It arrises well, but, as stated above, is not a favourite with the trade, as its hardness makes it expensive to dress.

WANGARATTA, Vic.—This stone is of unusual colour for a sandstone, having pinkish markings on a yellowish ground. It has been used in Melbourne in Collin's Buildings with effect, and the Wangaratta Cathedral has also been constructed from this material.

YASS, N.S.W.—At the Gap and Barber's Mill Quarry a sandstone has been quarried and used in some quantity in locally constructed edifices, such as churches, &c. It is grey in colour, and has a fairly even texture, but there is no data so far available concerning its durability. A blue-coloured calcareous sandstone is employed locally in large buildings, and so far appears to give satisfaction. A bed occurs near the banks of the Yass River, and is easily quarried and dressed, and so is a good freestone.

The following are some of the principal Tasmanian Sandstone Quarries:—

Bellerive;
Brighton;
Bryn Estyn;
Campania;
Domain;
Knocklofty;
Lindisfarne;
Oakhampton;
Risdon;
Spring Bay;
Tea Tree;
Waterworks.

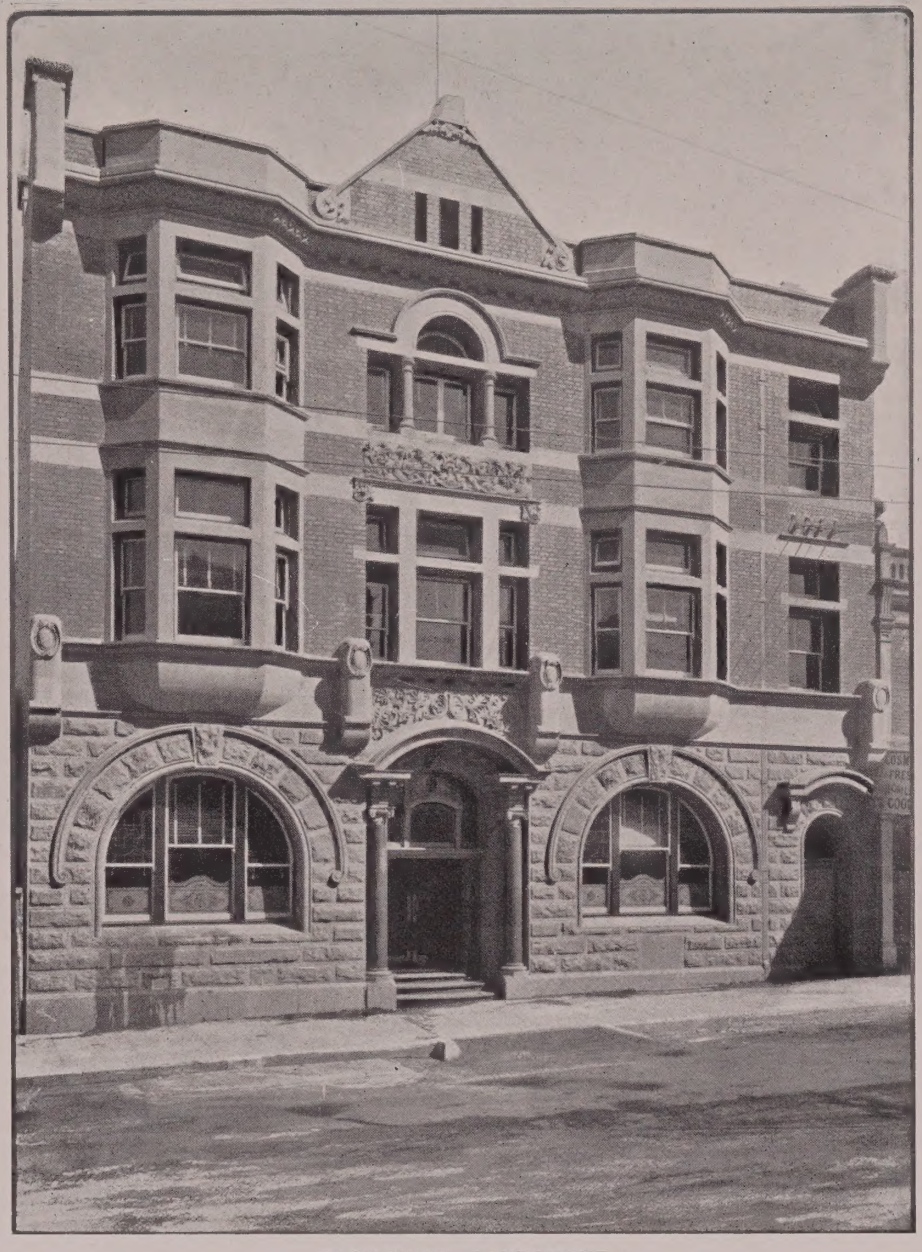


MAIN BUILDING WATERWORKS QUARRY. TRACERY, TEA TREE AND BRIGHTON QUARRIES.

(ST. DAVID'S CATHEDRAL, HOBART, TAS.)

FACED WITH BRIGHTON AND TEA TREE SANDSTONE

(POST OFFICE LAUNCESTON, TAS.)



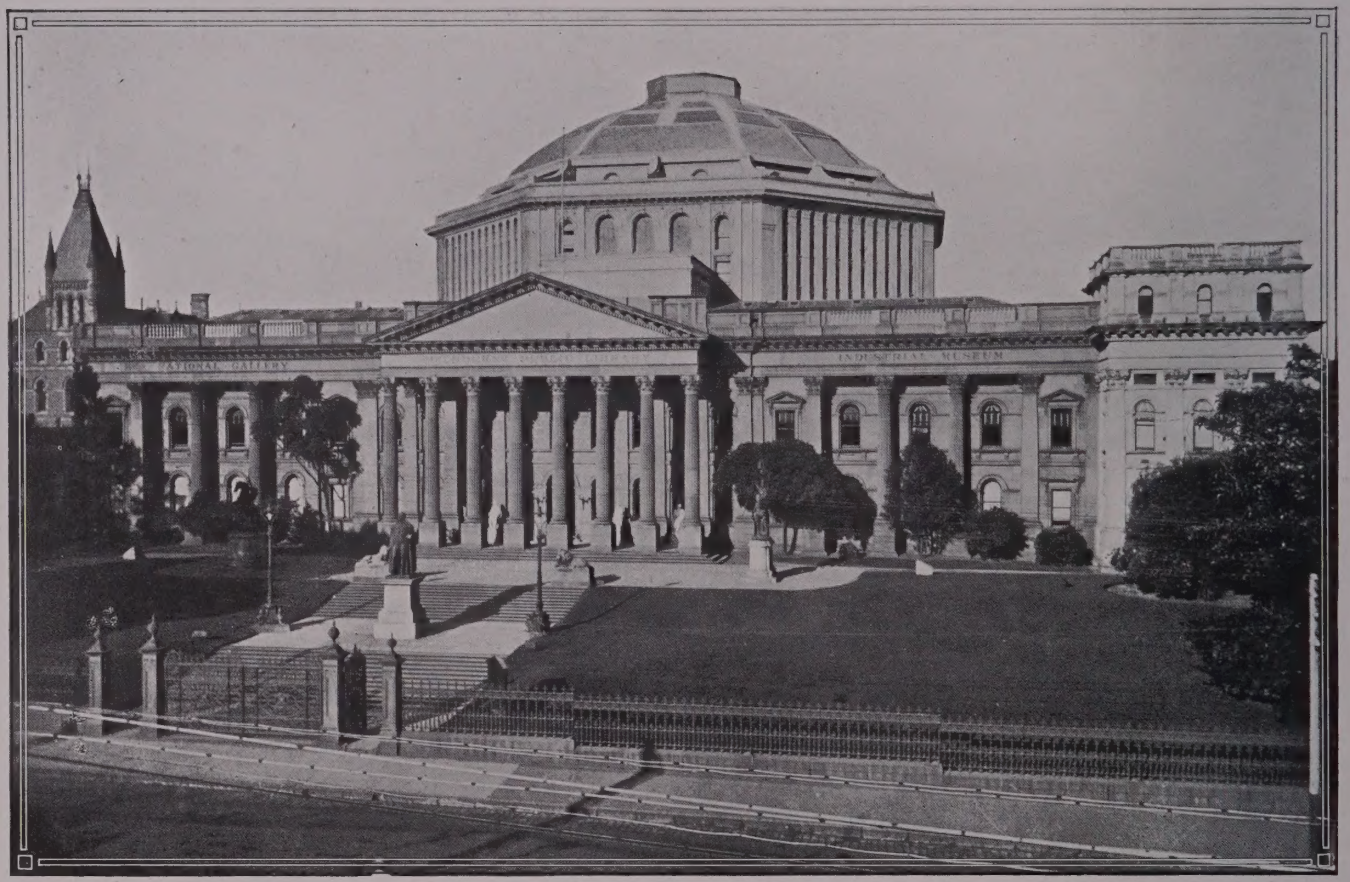
TASMANIAN SANDSTONE.

(COMMERCIAL TRAVELLERS' CLUB, LAUNCESTON, TAS.)

ROSS SANDSTONE.

(ST. JOHN'S CHURCH, ROSS, TAS.)

CAMPANIA SANDSTONE, TASMANIA.
(CUSTOMS HOUSE, HOBART.)



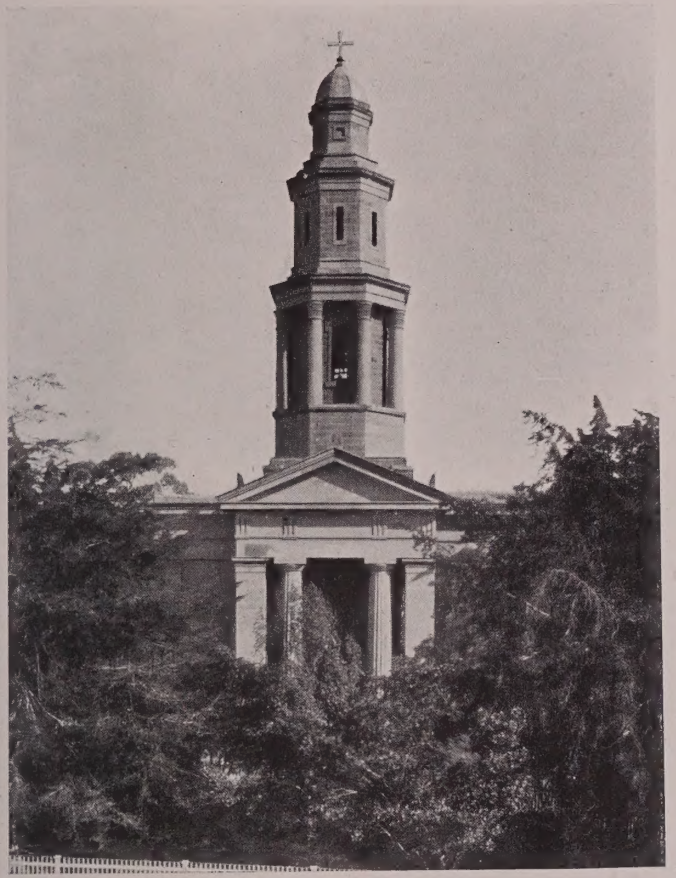
TASMANIAN SANDSTONE.

(NEW TECHNOLOGICAL MUSEUM, MELBOURNE.)

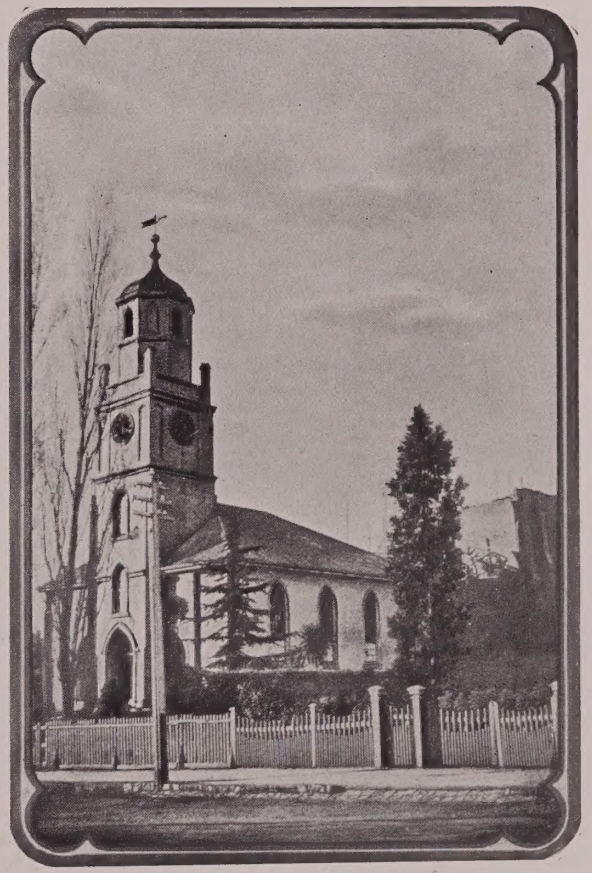
TASMANIAN AND STAWELL (VIC.) SANDSTONE.

(TOWN HALL, MELBOURNE.)

BASE COURSES, RISDON QUARRIES. UPPER STRUCTURE, BRYN ESTYN QUARRIES.
(G.P.O., HOBART, TAS.)

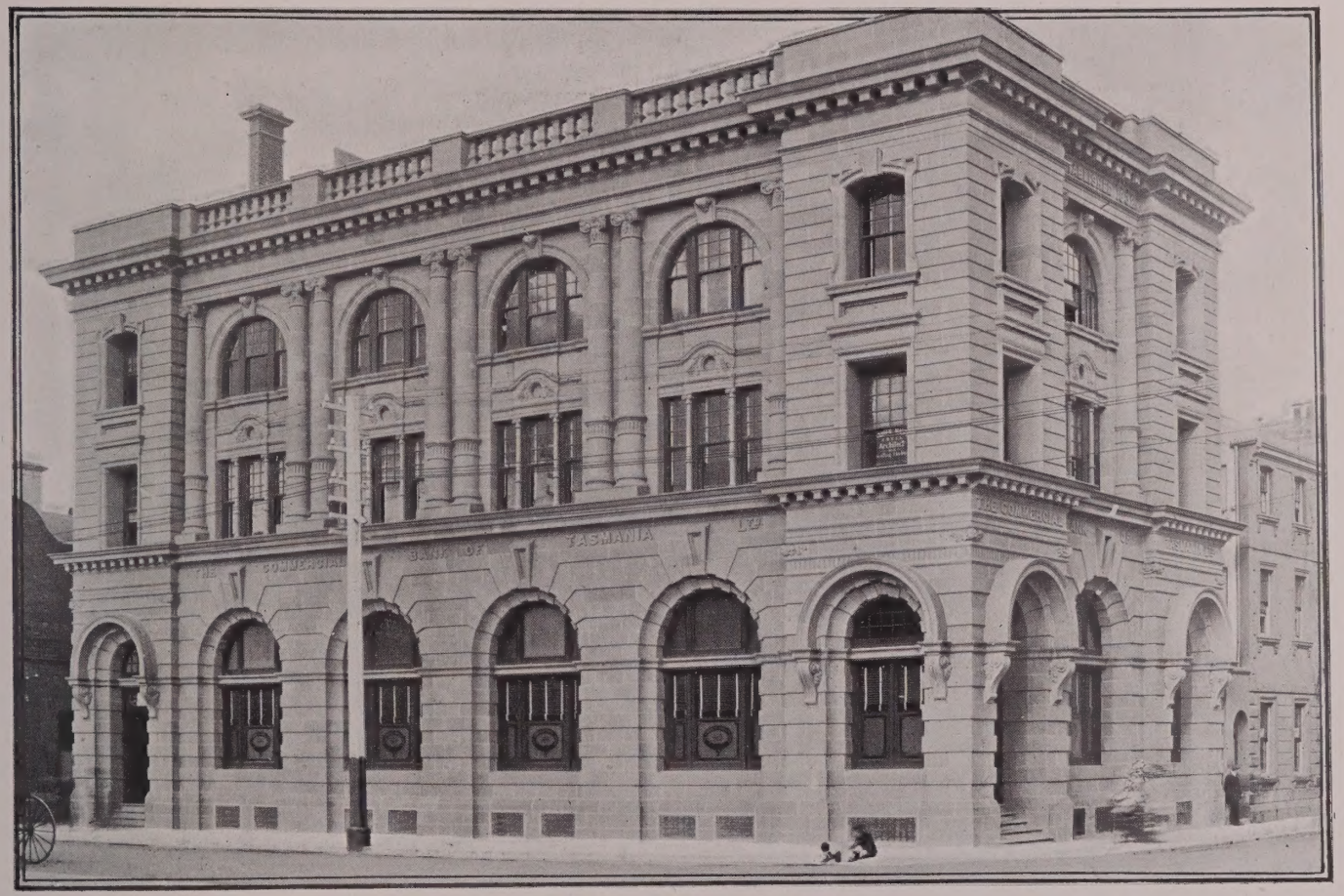


HOBART SANDSTONE.
(ST. GEORGE'S CHURCH, HOBART, TAS.)



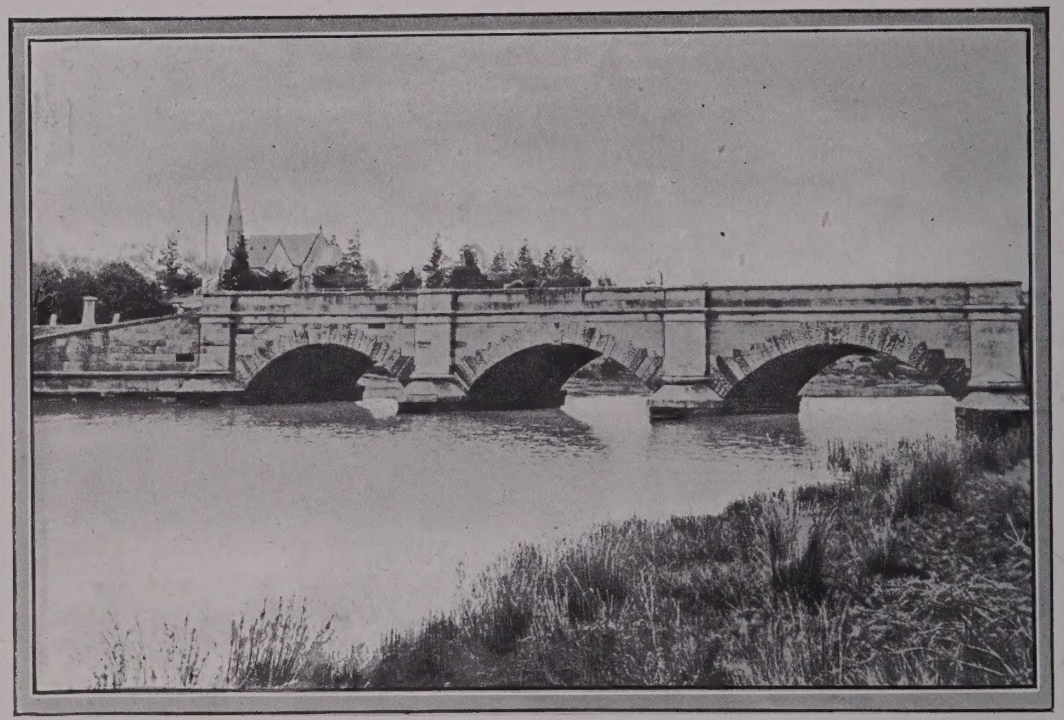
ROSS SANDSTONE.
(ST. JOHN'S CHURCH, LAUNCESTON, TAS.)

HOBART SANDSTONES.
(HOBART, TAS.)



ROSS SANDSTONE, TASMANIA.

(COMMERCIAL BANK OF TASMANIA, LAUNCESTON.)



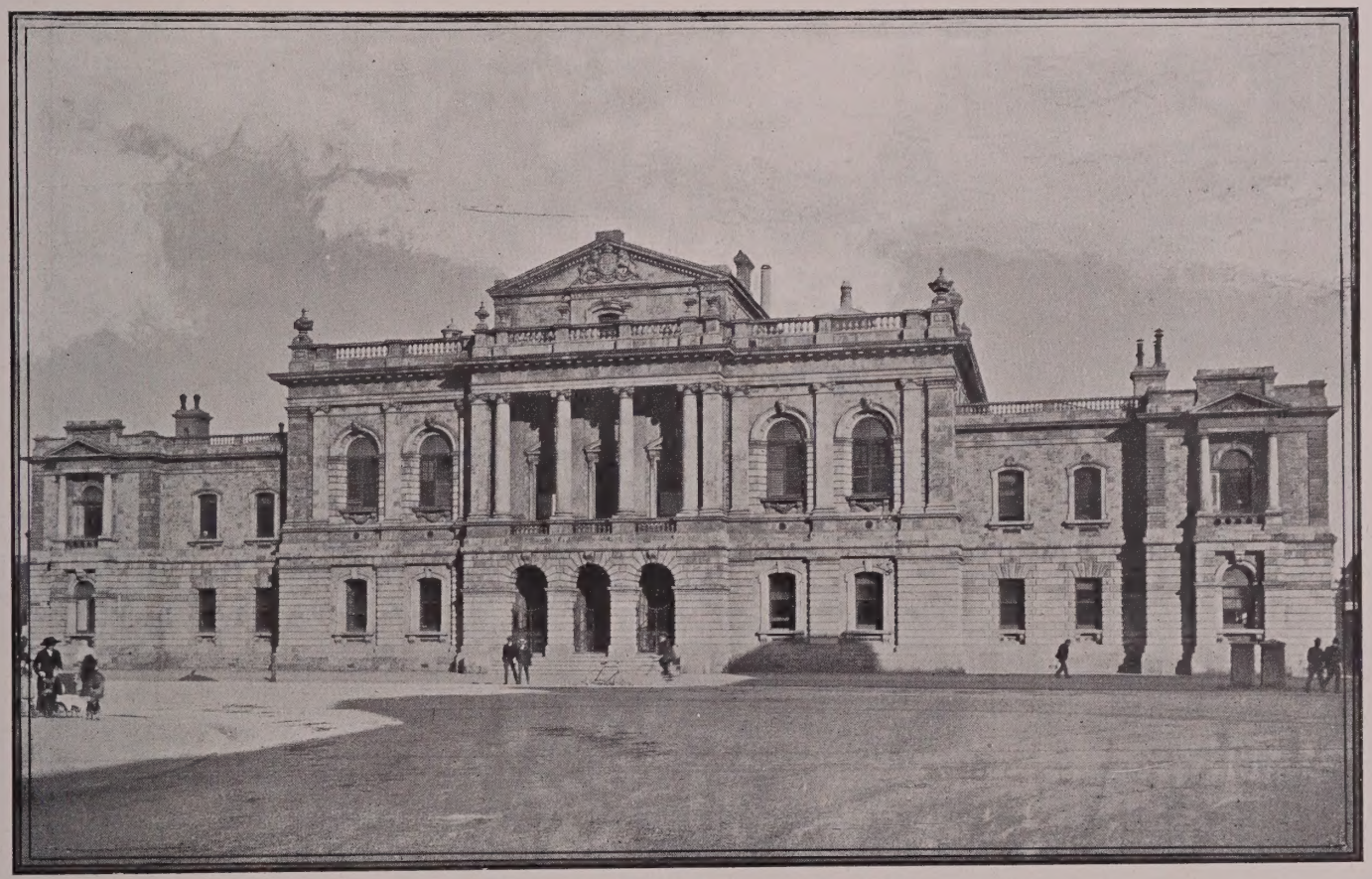
ROSS SANDSTONE.
(ROSS, TAS.)

STAWELL AND TASMANIAN SANDSTONE TASMANIA.

(POST OFFICE, MELBOURNE.)

TEA TREE GULLY AND MURRAY BRIDGE SANDSTONE.

(G.P.O., ADELAIDE, S.A.)



TEA TREE GULLY SANDSTONE.
(LAW COURTS, ADELAIDE, S.A.)

TEA TREE GULLY SANDSTONE.

(TOWN HALL, ADELAIDE, S.A.)

BASE AND PEDESTAL OF BUNDANOON SANDSTONE.

SOLDIERS' MEMORIAL, GOULBURN, N.S.W.

APPENDIX.

Crushing and Heat-resisting Tests of N.S.W. Stones.

(*a*) TABLE showing the Crushing Strength of some well known Australian Building Stones.*

No.	——	Locality where obtained.	Size of specimen in inches.	Strength in tons per sq. in.	Rate of load applied in tons per minute.
1	Sandstone	Belmore	3·06 × 3·06 × 3·07	7·13	11·13
2	,, ...	,, ...	3·08 × 3·08 × 3·06	5·25	.....
3	,, ...	,, ...	3·05 × 3·05 × 3·08	6·46	10·02
1	Sandstone	Bundanoon	3·01 × 3·03 × 2·99	2·50	2·53
2	,, ...	,, ...	3·00 × 2·99 × 3·00	2·63	2·28
3	,, ...	,, ...	3·07 × 3·04 × 3·06	2·47	2·30
1	Sandstone	Pyrmont	3·00 × 3·00 × 3·04	2·17	2·79
2	,, ...	,, ...	3·02 × 2·93 × 3·00	2·52	2·47
3	,, ...	,, ...	3·00 × 2·98 × 3·06	2·57	2·55
1	Sandstone	Ravensfield	3·04 × 3·04 × 3·06	4·72	3·63
2	,, ...	,, ...	3·04 × 3·02 × 3·04	4·85	4·45
1	Sandstone	Willoughby	3·04 × 3·12 × 3·07	1·83	2·17
2	,, ...	,, ...	3·02 × 3·08 × 3·05	1·59	3·70
3	,, ...	,, ...	3·10 × 3·04 × 3·06	1·73	2·32
1	Trachyte	Bowral	3·04 × 3·05 × 3·10	7·44	9·85
2	,, ...	,, ...	3·05 × 3·01 × 3·04	8·06	8·23
3	,, ...	,, ...	3·00 × 3·04 × 3·05	9·37	7·77
1	Granite	Barren Jack	3·05 × 3·05 × 3·05	7·61	8·84
2	,, ...	,, ...	3·08 × 3·07 × 3·03	5·59	7·55
3	,, ...	,, ...	3·08 × 3·09 × 3·09	7·41	11·73

*Baker and Nangle, Roy. Soc. N.S.W., vol. xliii, p. 190.

TABLE showing the Crushing Strength of some well known Australian Building Stones*—*continued.*

No.	——	Locality where obtained.	Size of specimen in inches.	Strength in tons per sq. in.	Rate of load applied in tons per minute.
1	Granite	Gabo Island	3·09 × 3·12 × 3·12	6·80	13·12
2	,, ...	,, ...	3·07 × 3·10 × 3·13	6·67	15·86
3	,, ...	,, ...	3·08 × 3·11 × 3·12	7·83	7·00
1	Granite	Moruya	3·05 × 2·96 × 3·05	5·93	.....
2	,, ...	,, ...	3·08 × 3·06 × 3·05	6·75	15·91
3	,, ...	,, ...	3·05 × 2·99 × 3·07	6·28	19·05
2	Granite	Tenterfield	2·77 × 2·77 × 2·78	5·21	13·33
3	,, ...	,, ...	3·04 × 3·00 × 3·09	6·02	.....
1	Marble	Attunga	3·05 × 3·06 × 3·06	5·38	.....
2	,, ...	,, ...	2·99 × 3·01 × 3·06	4·34	.....
3	,, ...	,, ...	3·03 × 3·02 × 3·06	3·84	2·50
1	Marble	Warialda	3·04 × 3·08 × 3·06	3·18	3·72
2	,, ...	,, ...	3·04 × 3·12 × 3·09	1·77	5·61
3	,, ...	,, ...	3·03 × 3·07 × 3·04	1·07	5·00
1	Marble	Caleula	3·00 × 3·03 × 3·01	9·44	6·60
2	,, ...	,, ...	3·02 × 3·03 × 3·03	7·09	8·11
3	,, ...	,, ...	2·98 × 3·03 × 3·03	6·09	10·99
1	Marble	Kempsey	3·02 × 3·02 × 3·03	6·69	8·72
2	,, ...	,, ...	3·01 × 3·02 × 3·01	6·66	7·57
3	,, ...	,, ...	3·01 × 3·02 × 3·02	7·99	14·54
1	Marble	Fernbrook	3·02 × 3·03 × 3·02	7·28	11·11
3	,, ...	,, ...	3·02 × 3·03 × 3·00	8·31	12·68
1	Marble	Borenore	3·01 × 3·01 × 2·97	5·46	7·07
2	,, ...	,, ...	3·00 × 2·97 × 3·01	5·16	4·18
3	,, ...	,, ...	3·00 × 2·97 × 3·02	5·92	2·63
2	,, ...	Fernbrook	3·01 × 3·03 × 3·00	4·66	2·68
1	,, ...	Springhill	3·03 × 3·01 × 3·00	7·47	2·52

* Baker and Nangle, Roy. Soc. N.S.W., vol. xliii, p. 190.

(*b*) THE EFFECTS OF HEAT AND WATER ON NEW SOUTH WALES BUILDING STONES.

No.	Specimen.	Temperature of Furnace.	Time in Furnace.	How Treated and Remarks.
		°C.	Minutes.	
1	Pyrmont Sandstone ...	750	15	Plunged suddenly into cold water at 12° C. Practically no effect. Edges unchipped, colour considerably deepened, otherwise uninjured.
2	,, ,, ...	746	20	Cooled slowly in air, colour changed from straw yellow to pale pink, otherwise uninjured.
3	,, ,, ...	800	15	Half submerged in cold water. A crack at once appeared at right angles to the surface of water.
4	,, ,, ...	760	45	Heated gradually during 45 minutes and half submerged in cold water; after short interval cooled under tap; uninjured.
5	Bundanoon Sandstone	751	25	Half submerged in cold water; afterwards cooled beneath tap. Change in colour very slight, faint crack appeared across the cube at right angles to surface of water. No change in texture.
6	,, ,, ...	785	20	Plunged suddenly into cold water at 11° C. Deepening of colour hardly perceptible, small piece flaked off from one edge. No change in character.
7	,, ,, ...	792	15	Plunged suddenly into cold water; entirely unaffected, edges unchipped.
8	,, ,, ...	822	20	Half submerged in cold water. A prominent crack and one very small crack at once appeared at right angles to the surface of the water. No change in character.
9	,, ,, ...	674	30	The specimen was placed in the furnace, which was gradually heated for half an hour, when the temperature was ascertained and the specimen taken out and a spray of cold water played on it till cooled. The result was nil.

Effect of Heat and Water on New South Wales Building Stones—*continued.*

No.	Specimen.	Temperature of Furnace.	Time in Furnace.	How Treated and Remarks.
		°C.	Minutes.	
10	Bundanoon Sandstone	674	30	Similar treatment to No. 9, with almost similar results, only a slight breakage on one edge.
11	Willoughby Sandstone	674	30	A coarser grained stone than No. 9, changed slightly in colour, otherwise similar results to No. 9.
12	,, ,, ...	674	30	
13	Bowral Trachyte ...	843	15	Suddenly plunged into cold water; badly cracked in several places, colour changed to dark brown.
14	,, ,, ...	767	20	Semi-submerged in cold water; afterwards cooled off beneath tap. Badly cracked along edge on portion submerged, colour changed to deep brown.
15	Moruya Granite ...	806	15	Seven minutes after entry into furnace badly cracked in several places. On removal quite shattered into small fragments.
16	,, ,, ...	806	15	Ten minutes after entry into furnace this specimen showed number of small cracks. On removal plunged into cold water, immediately flew to pieces with report.
17	Barren Jack Granite	830	15	After 3 minutes cracked across diagonally. Removed after 15 minutes and allowed to cool slowly; cracked in several places but not shattered; otherwise stood the test well.
18	,, ,, ...	784	45	Allowed to heat gradually in furnace, taken out unaltered and plunged into cold water; several prominent cracks at once appeared, otherwise stood the test well.
19	Gabo Island Granite...	783	35	The cube was placed in cold furnace and heated gradually. At 717° a small crack appeared. After removal, cube very badly cracked in many places—almost shattered.

Effect of Heat and Water on New South Wales Building Stones—*continued.*

No.	Specimen	Temperature of Furnace.	Time in Furnace.	How Treated and Remarks.
		° C.	Minutes.	
20	Gabo Island Granite...	544	20	Heated gradually and plunged suddenly into cold water. Almost unaffected; several small cracks can be seen on close examination.
21	Tenterfield Granite ...	701	30	Heated gradually, at 701° it was noticed that the cube was cracked, and on removal it crumbled into fragments.
22	„ „ ...	544	20	Heated gradually and plunged suddenly into cold water. Almost unaffected; on close examination several small cracks could be seen to be developed.
23	Nemingha Marble ...	542	25	Heated gradually and cooled slowly in air. Calcination not started and rock unaltered.
24	„ „ ...	719	25	This specimen was placed in the hot furnace, but owing to trouble with the furnace, the temperature became much reduced, but was afterwards raised again. The specimen on removal was plunged into cold water; cracks appeared in several places, but the calcination was only slight. Came through the test fairly well.
25	Warialda Marble ...	744	35	Heated gradually and cooled in air. Specimen ruined.
26	Attunga Marble ...	758	40	Heated gradually and cooled in air. Specimen broken into pieces.
27	Warialda Marble ...	808	10	Placed in hot furnace. Cracked slightly on removal. Plunged into cold water, broke in two pieces. Specimen ruined.
28	Attunga Marble ...	802	10	Placed in hot furnace. Cracked slightly on removal. Plunged into cold water, badly cracked in several places. Specimen quite disfigured.

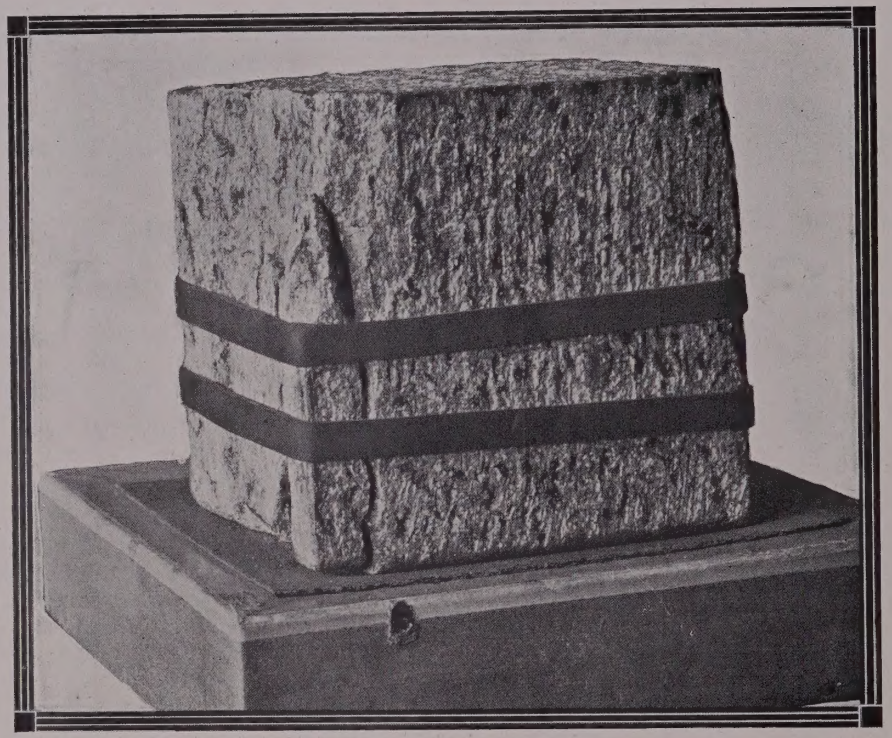
Effect of Heat and Water on New South Wales Building Stones—*continued.*

No.	Specimen.	Temperature of Furnace.	Time in Furnace.	How Treated and Remarks.
		° C.	Minutes.	
29	Fernbrook Marble ...	695	30	The furnace was gradually heated up to this temperature when the specimen was taken out and a spray of cold water played upon it. The original colour was quite destroyed, although the edges remained intact.
30	„ „ ...	695	30	The furnace was gradually heated up to this temperature when the specimen was taken out and a spray of cold water played upon it. The original colour was quite destroyed although the edges remained intact but calcined.
31	Caleula Marble ...	695	30	Ditto, ditto, ditto, colour not so obliterated as 29 and 30, but more edges were calcined.
32	„ „ ...	695	30	Ditto, ditto, but edges still further calcined.
33	Springhill Marble ...	656	45	Similar conditions to No. 35, but very much less affected ; original structure still retained, and much of the colour.
34	„ „ ...	656	45	
35	Windellama Marble ...	656	45	The furnace was gradually heated up to this temperature during this time, when the specimen was taken out and a spray of cold water played on it. The original colour was quite destroyed on the surface and specimen cracked.
36	„ „ ...	656	45	Similar conditions to 35, but after half an hour the specimen burst with a loud report into four pieces.
37 and 38	Blue Borenore Marble	648	30	Placed in a furnace heated to this temperature and left for half an hour. Fared badly, for when the stream of cold water was played upon them they cracked in several directions, lost original colour and became almost calcined.

All the above specimens are now placed permanently in the Technological Museum, Sydney.

Specimen of Material after Testing by 100-ton Machine.

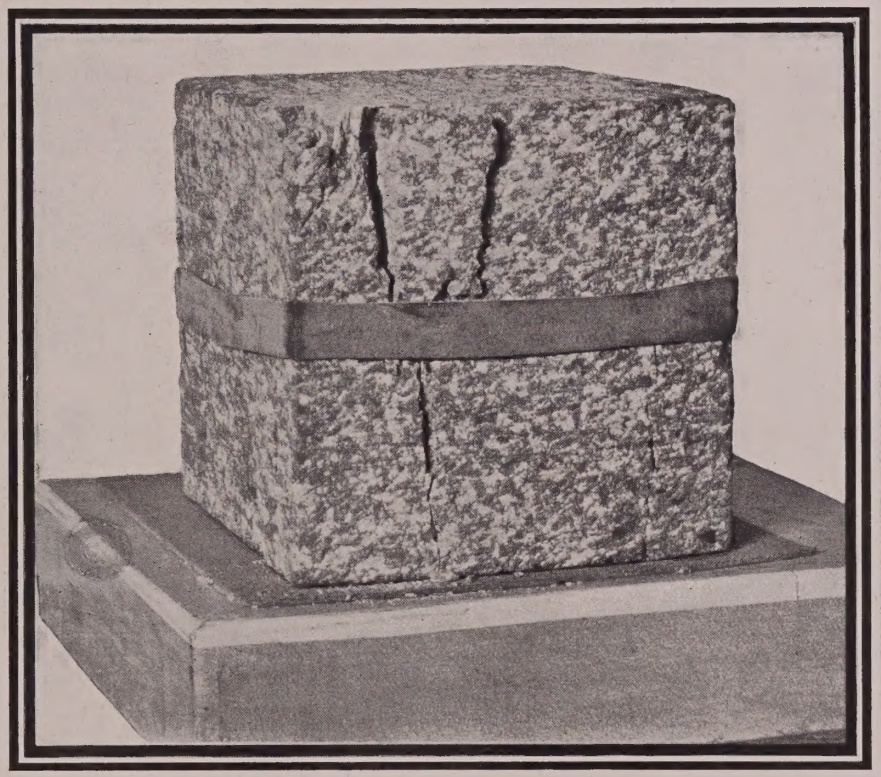
[Photographs by C. F. Laseron.]



BARREN JACK GRANITE, N.S.W.

3 IN. CUBE CRUSHED AT 66.69 TONS (J. NANGLE).

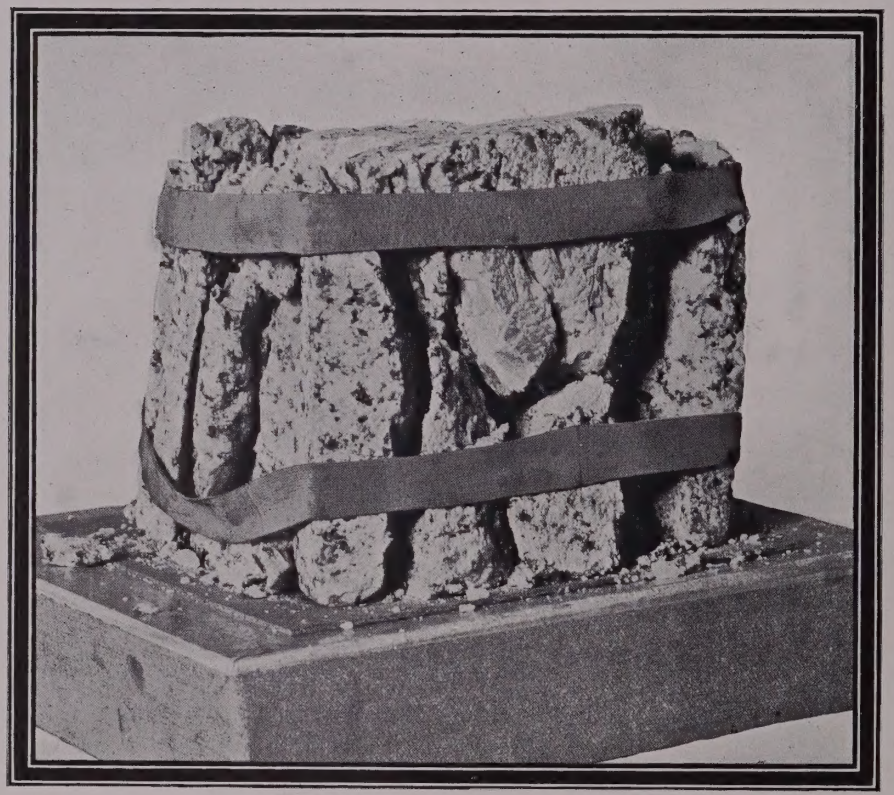
Specimen of Material after Testing by 100-ton Machine.



GABO ISLAND GRANITE, N.S.W.

3 IN. CUBE CRUSHED AT 65.79 TONS (J. NANGLE).

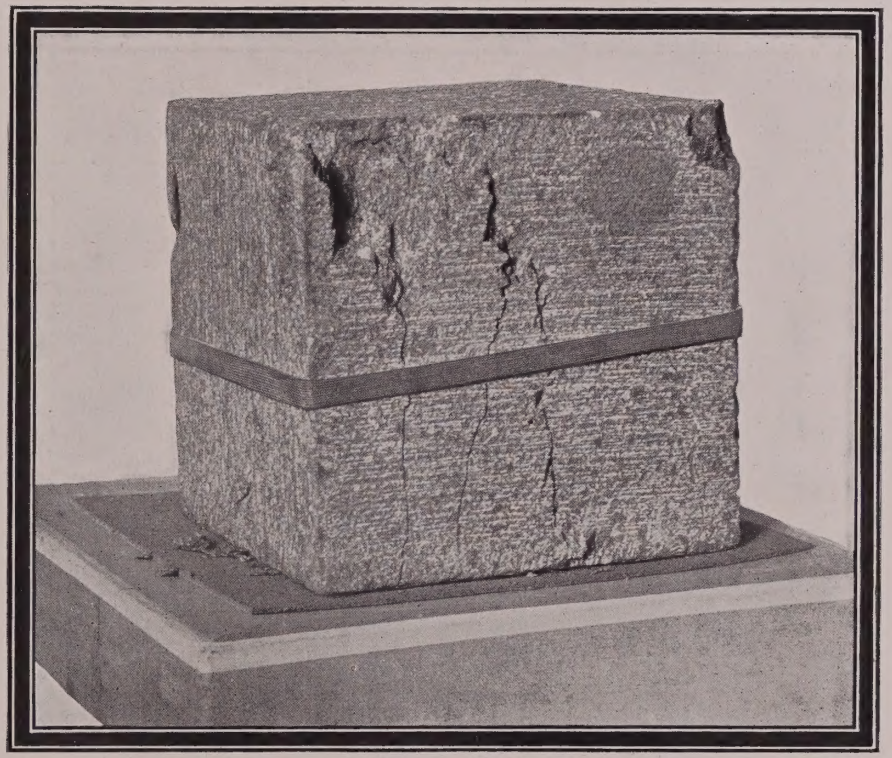
Specimen of Material after Testing by 100-ton Machine.



TENTERFIELD GRANITE, N.S.W.

3 IN. CUBE CRUSHED AT 54.18 TONS (J. NANGLE)

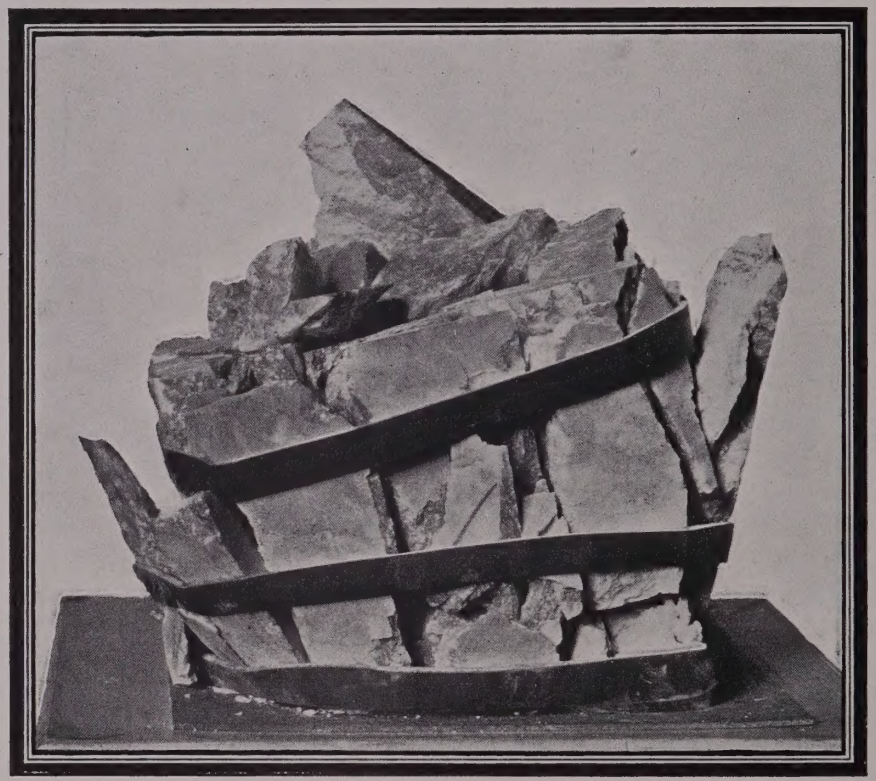
Specimen of Material after Testing by 100-ton Machine.



BOWRAL TRACHYTE N.S.W.

3 IN. CUBE CRUSHED AT 84.33 TONS (J. NANGLE).

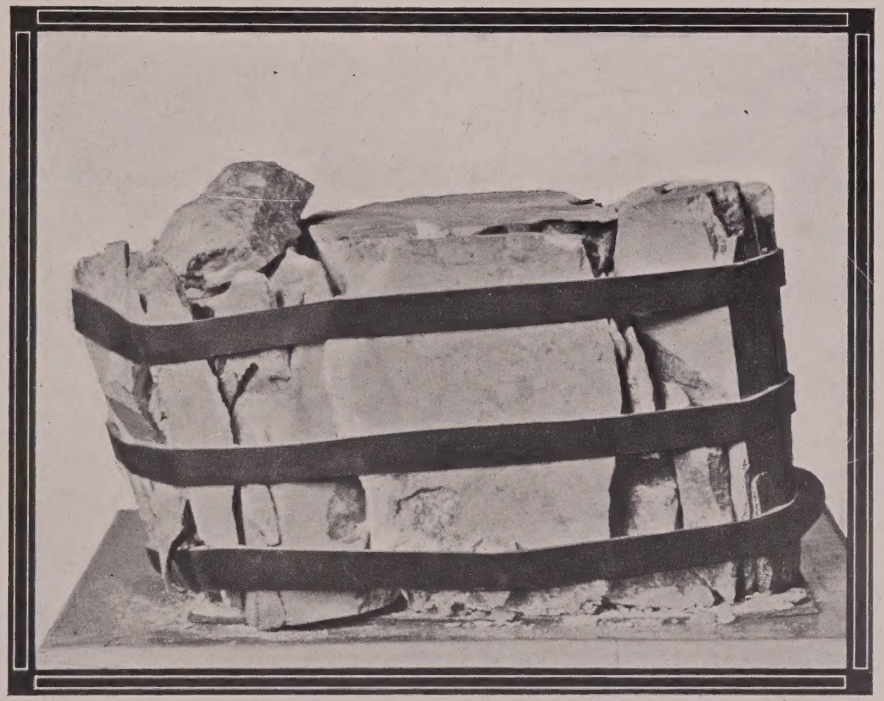
Specimen of Material after Testing by 100-ton Machine.



CALEULA MARBLE, N.S.W.

3 IN. CUBE CRUSHED AT 84.96 TONS (J. NANGLE).

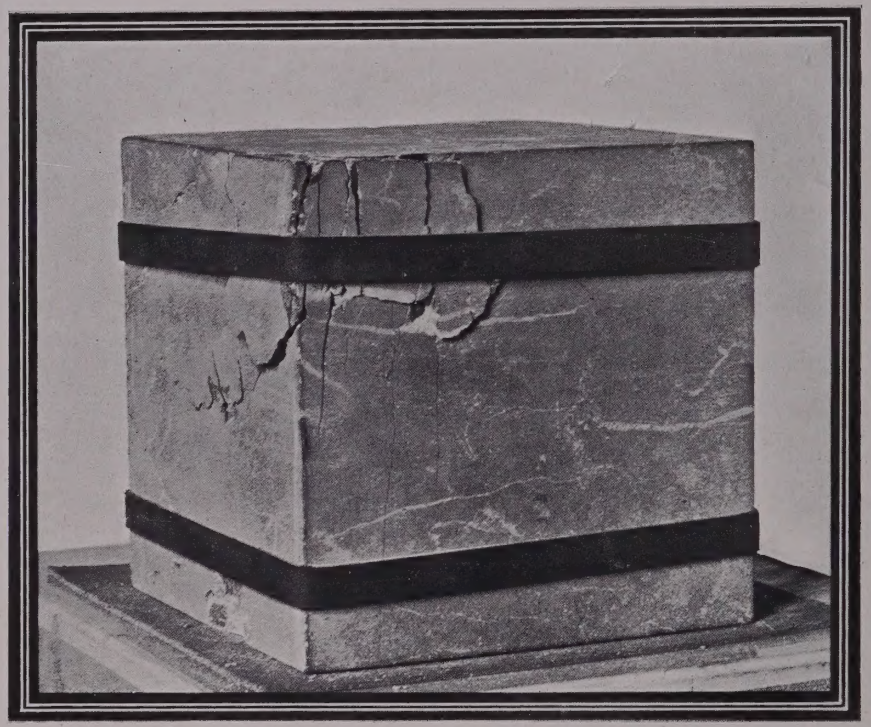
Specimen of Material after Testing by 100-ton Machine.



FERNBROOK MARBLE, N.S.W.

3 IN. CUBE CRUSHED AT 74.79 TONS (J. NANGLE).

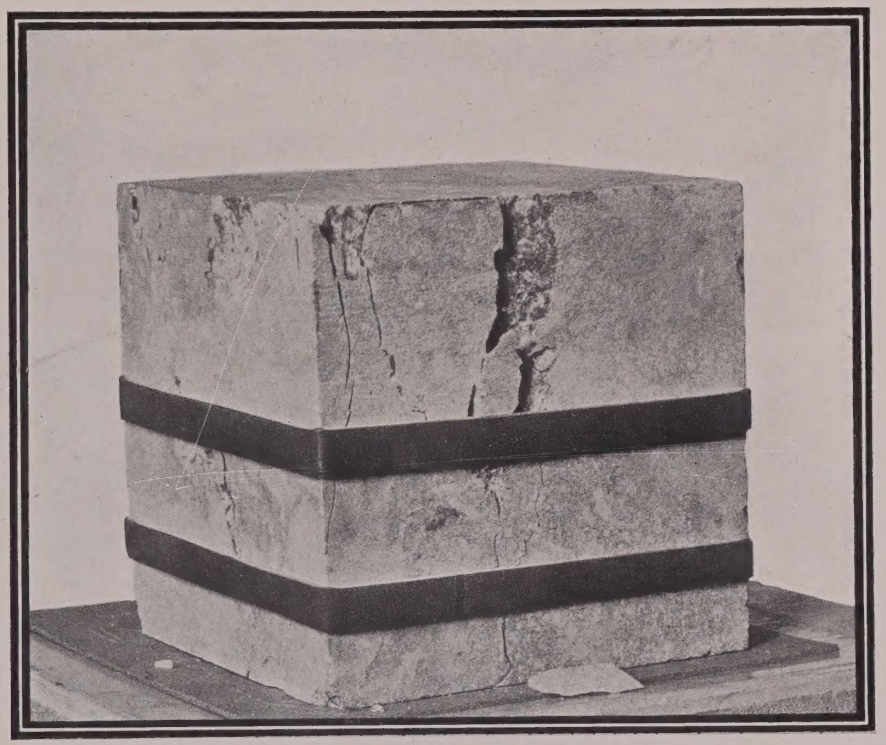
Specimen of Material after Testing by 100-ton Machine.



SPRINGHILL MARBLE, N.S.W.

3 IN. CUBE CRUSHED AT 68.18 TONS (J. NANGLE).

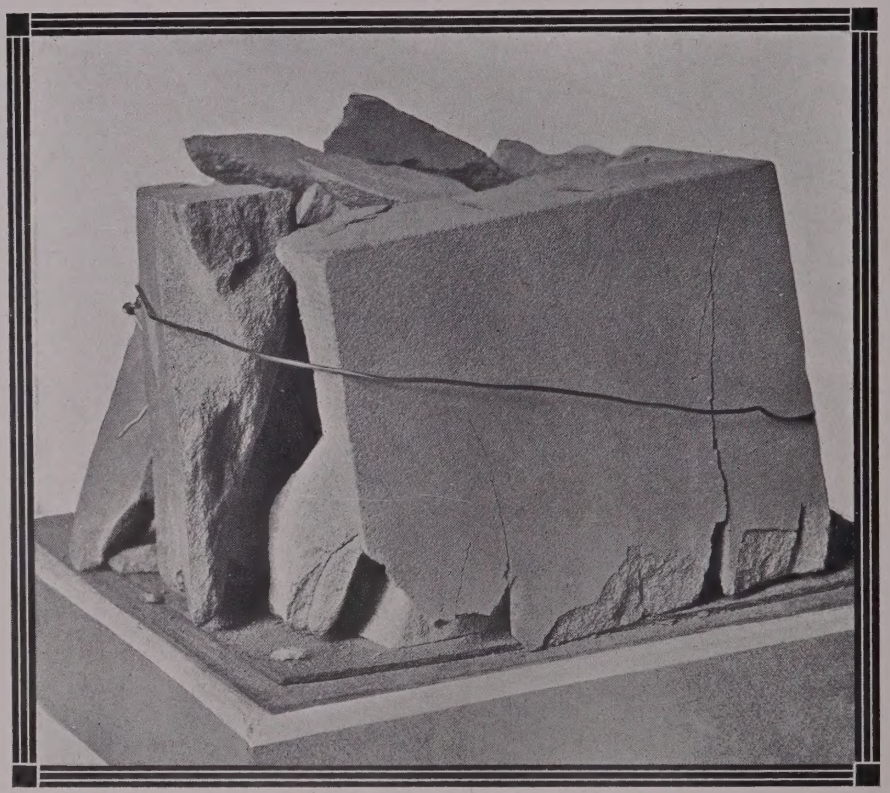
Specimen of Material after Testing by 100-ton Machine.



BORENORE MARBLE, N.S.W.

3 IN. CUBE CRUSHED AT 52.75 TONS (J. NANGLE).

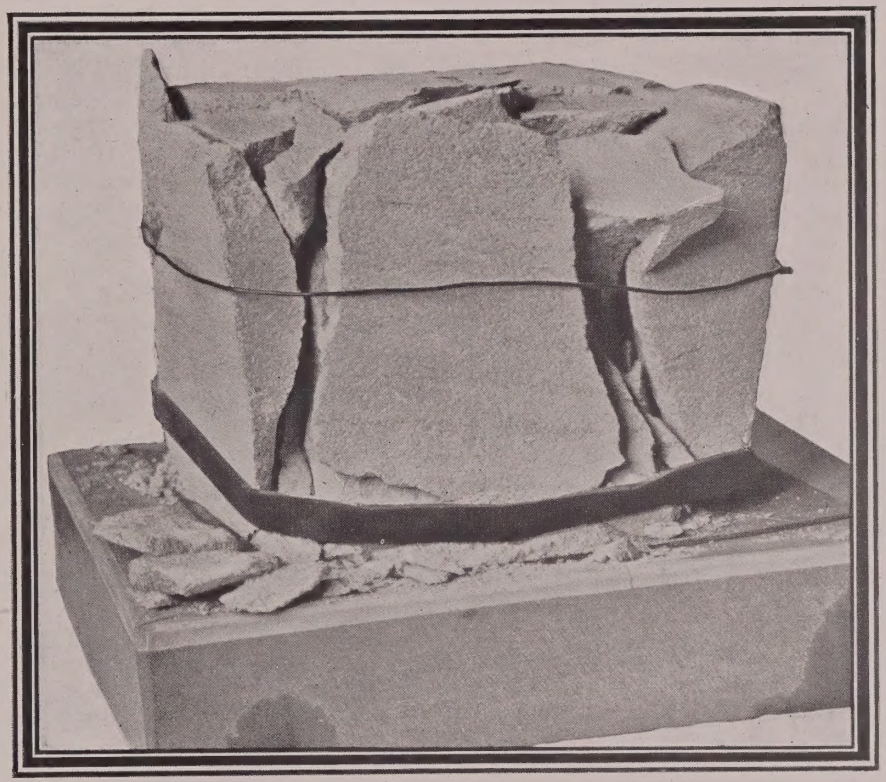
Specimen of Material after Testing by 100-ton Machine.



RAVENSFIELD SANDSTONE, N.S.W.

3 IN. CUBE CRUSHED AT 42.48 TONS (J. NANGLE).

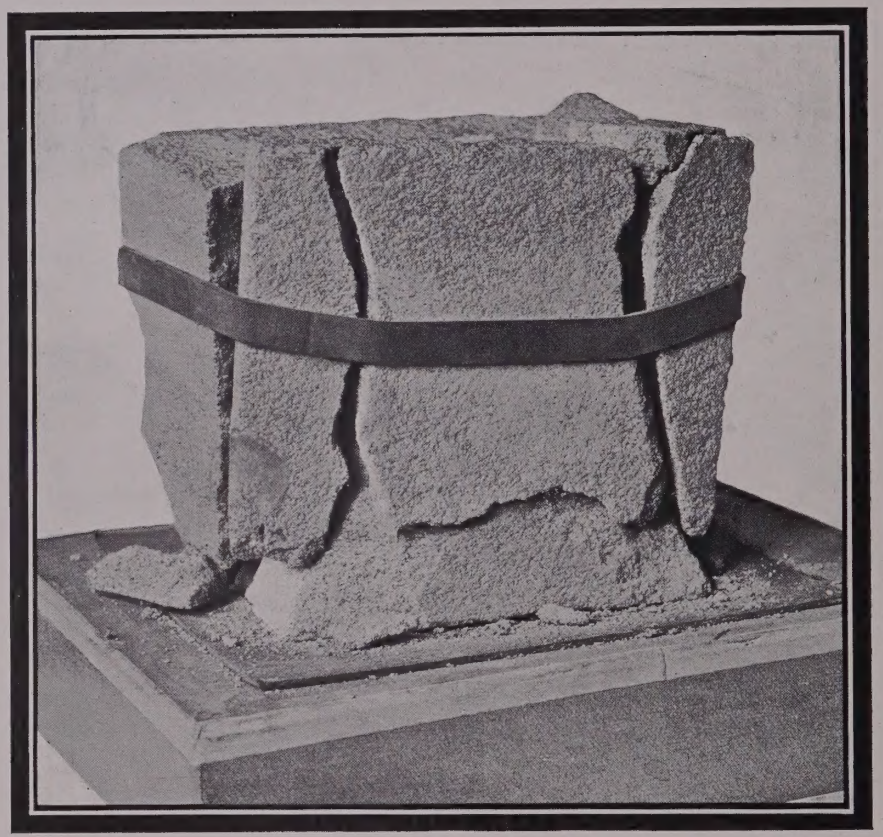
Specimen of Material after Testing by 100-ton Machine.



BUNDANOON SANDSTONE, N.S.W.

3 IN. CUBE CRUSHED AT 23.13 TONS (J. NANGLE).

Specimen of Material after Testing by 100-ton Machine.



SYDNEY SANDSTONE, N.S.W.

3 IN. CUBE CRUSHED AT 22.83 TONS (J. NANGLE).

Compression Tests—Victorian Sandstones.*

Stone.	Size of cube in inches.	Total Strength in lb.	Strength in lb. per sq. in.
Stawell	3	100,300 (crack at 90,000)	11,255
,, ...	2	70,200	17,550
,, ...	2	70,000	17,500
Dunkeld	3	50,750	5,640
,, ...	3	39,250	4,360
Barrabool Hills	3	29,670	3,297
,, ...	3†	26,500	3,195
Apollo Bay	3	61,500	6,833
,, ...	3†	73,900	7,866
Bacchus Marsh	3	17,750	1,940
Darley	3	10,300	1,144
Egerton (fine)	3	38,600	4,288
,, (coarse)	3	18,300	2,033‡
,, ,, ...	3	27,300	3,033‡
Greendale	3	21,600	2,400
Sydney, N.S.W.	3	66,300	7,366
,, ...	3	43,200	4,800

* H. C. Richards, Proc. Royal Soc. of Victoria, 1909, p. 182. † Approx. ‡ Perp. to bed.

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VERY little has as yet been written specifically upon the Building and Ornamental Stones of Australia, but the following works have been referred to in the course of this research :—

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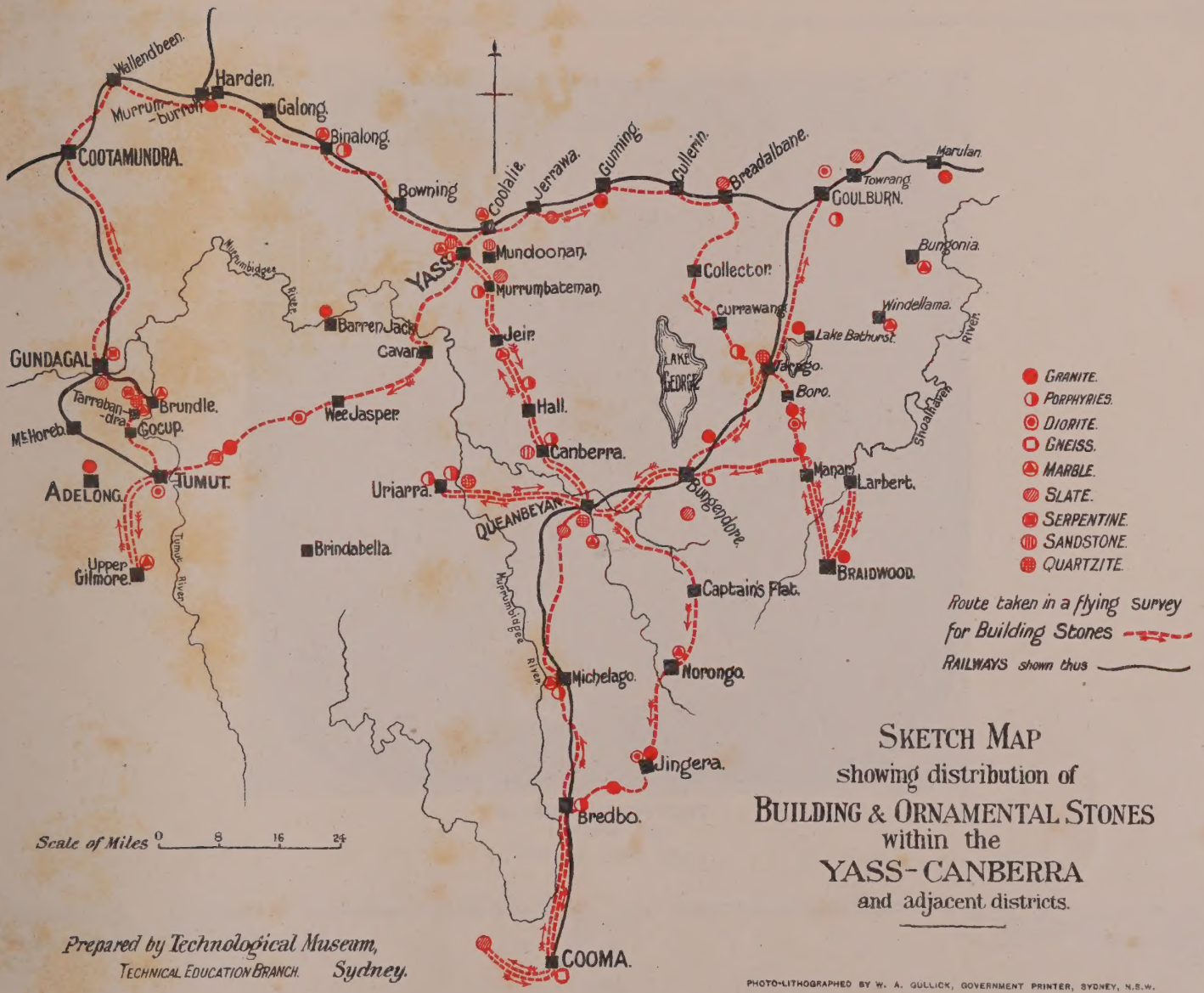
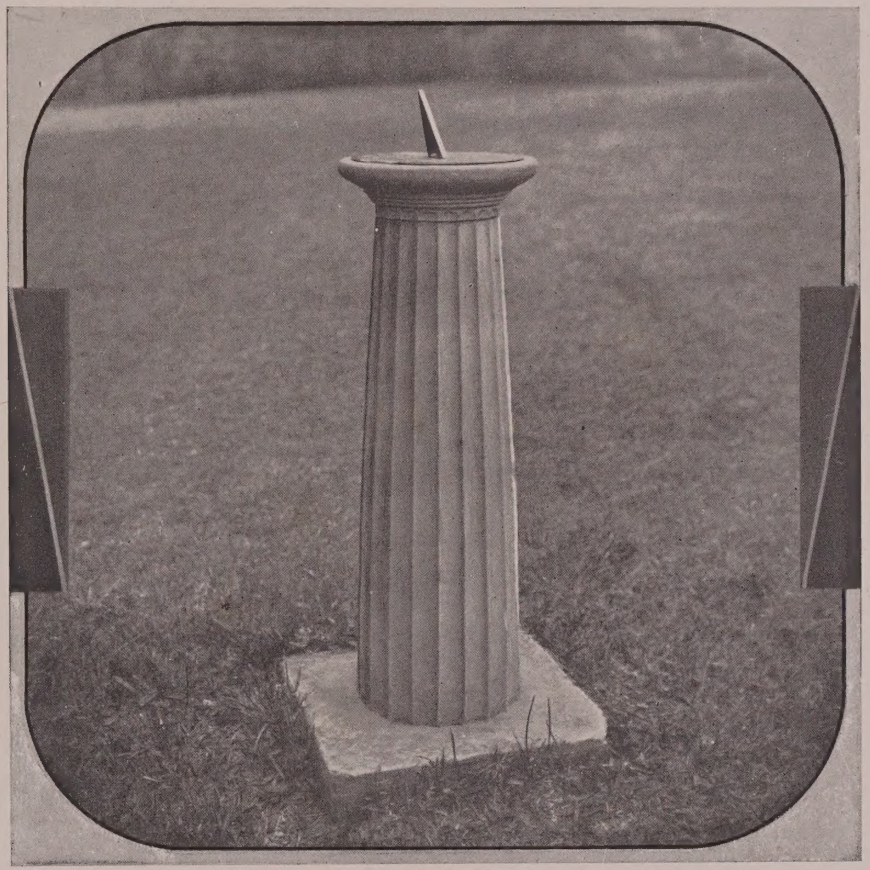


SKETCH MAP
showing distribution of
BUILDING & ORNAMENTAL STONES
within the
YASS-CANBERRA
and adjacent districts.

Prepared by Technological Museum,
TECHNICAL EDUCATION BRANCH. *Sydney.*

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.



SYDNEY SANDSTONE.

[*Erected in* 1835.]

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